

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

TRW VEHICLE SAFETY SYSTEMS INC.
4505 W. 26 Mile Rd.
Washington, MI 48094

and

TRW AUTOMOTIVE GmbH
Industriestrasse 20
D 73551
Aldorf, Germany

Plaintiff,

v.

TAKATA CORPORATION
1-4-30 Roppongi
Minato-ku
Tokyo 106-8510
Japan

and

TK HOLDINGS, INC.
2500 Takata Drive
Auburn Hills, MI 48326

and

TAKATA-PETRI AG
Bahnweg 1
63743
Aschaffenburg, Germany

Defendants.

Civil Action No. 08-268-GMS

DEMAND FOR TRIAL BY JURY

AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiffs TRW Vehicle Safety Systems Inc. (“VSSI”) and TRW Automotive GmbH (“GmbH”) (VSSI and GmbH collectively “TRW Companies”) for their Amended Complaint against Defendants Takata Corporation, TK Holdings Inc. and Takata-Petri AG (collectively the “Defendants”) for injunctive and declaratory relief and for damages, including treble or multiple damages, for patent infringement, state and allege as follows:

NATURE OF THE ACTION

1. VSSI is the owner of United States Patent No. 5,490,690 (“the ‘690 Patent”), United States Patent No. 5,566,977 (“the ‘977 Patent”), United States Patent No. 5,782,489 (“the ‘489 Patent”), United States Patent No. 6,773,030 (“the ‘030 Patent”), and United States Patent No. 6,877,772 (“the ‘772 Patent”); and GmbH is the owner of United States Patent No. 5,957,487 (“the ‘487 Patent”), and United States Patent No. 6,155,595 (“the ‘595 Patent”) (collectively the “Patents-in-Suit”).

2. This is a civil action for the infringement of the Patents-in-Suit, including the willful infringement of the Patents-in-Suit by Defendants.

3. The technology at issue involves the design, manufacture, sale and importation of safety restraint systems and components used in automobiles.

THE PARTIES

4. Plaintiff VSSI is a corporation organized under the laws of Delaware, having a place of business located in Washington, Michigan. Plaintiff GmbH is a corporation organized under the laws of Germany, having a place of business located in Aldorf, Germany.

5. Defendant Takata Corporation is a Japanese corporation, having its principal place of business at 1-4-30 Roppongi, Minato-ku, Tokyo 106-8510 Japan. Takata manufactures safety restraint products and, on information and belief, directs those products to the United States, including Delaware, through established distribution channels involving various third parties, knowing that these third parties will use their respective nationwide contacts and distribution channels to import into, sell, offer for sale, and/or use these products in Delaware and elsewhere in the United States.

6. Defendant TK Holdings, Inc. is a Delaware corporation, having its principal place of business at 2500 Takata Dr., Auburn Hills, MI 48326-2634. On information and belief, Takata Holdings, Inc. offers to sell, sells, and imports safety restraint systems and components to the United States, including Delaware, through established distribution channels involving various third parties, knowing that these third parties will use their respective nationwide contacts and distribution channels to import into, sell, offer for sale, and/or use these products in Delaware and elsewhere in the United States.

7. Defendant Takata-Petri AG is a German corporation, having its principal place of business at Bahnweg 1, 63743 Aschaffenburg, Germany. On information and belief, Takata-Petri AG manufactures safety restraint products and, on information and belief, directs those products to the United States, including Delaware, through established distribution channels involving various third parties, knowing that these third parties will use their respective nationwide contacts and distribution channels to import into, sell, offer for sale, and/or use these products in Delaware and elsewhere in the United States.

JURISDICTION AND VENUE

8. This action is based upon and arises under the Patent Laws of the United States, 35 U.S.C. § 100 *et seq.*, and in particular §§ 271, 281, 283, 284 and 285, and is intended to redress infringement of the Patents-in-Suit owned by the TRW Companies.

9. This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

10. Defendants have transacted and continue to transact business in the United States and in this judicial district by: using or causing to be used; making; importing or causing to be imported; offering to sell or causing to be offered for sale; and/or selling or causing to be sold directly, through intermediaries and/or as an intermediary, a variety of products that infringe the Patents-in-Suit to customers in the United States, including customers in this judicial district, and Defendants will continue to do so unless enjoined by this Court.

11. This Court has personal jurisdiction over Takata Corporation, TK Holdings, Inc., and Takata-Petri AG and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c) and (d), and 28 U.S.C. § 1400(b), in that these Defendants are committing and are causing acts of patent infringement within the United States and within this judicial district, including the infringing acts alleged herein, both directly, through one or more intermediaries, and as an intermediary, and in that these Defendants have caused and cause injury and damages in this judicial district by acts or omissions outside this judicial district, including but not limited to utilization of their own distribution channels established in the United States, to ship a variety of products that infringe the Patents-in-Suit into the United States and into this judicial district

while deriving substantial revenue from services or things used or consumed within this judicial district, and will continue to do so unless enjoined by this Court.

12. This Court has personal jurisdiction over Takata Corporation, TK Holdings, Inc. and Takata-Petri AG and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c), and 28 U.S.C. § 1400(b), in that these Defendants are committing acts of patent infringement within the United States and within this judicial district, including the infringing acts alleged herein, both directly, through one or more intermediaries, and as an intermediary. TK Holdings, Inc. regularly imports safety restraint systems and products into the United States for distribution throughout the United States, including in this judicial district. Takata Corporation, TK Holdings, Inc. and Takata-Petri AG are involved in the distribution of infringing safety restraint systems and products and are aware that their products are sold throughout the United States, including in Delaware. By shipping into, offering to sell in, using, or selling products that infringe the Patents-in-Suit in this judicial district, or by inducing or causing those acts to occur, Takata Corporation, TK Holdings, Inc. and Takata-Petri AG have transacted and transact business and perform works and services in this judicial district, have contracted and contract to supply services and things in this judicial district, have caused and cause injury and damages in this judicial district by acts and omissions in this judicial district, and have caused and cause injury and damages in this judicial district by acts or omissions outside of this judicial district while deriving substantial revenue from services or things used or consumed within this judicial district, and will continue to do so unless enjoined by this Court.

13. This Court has personal jurisdiction over TK Holdings, Inc., and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c), and 28 U.S.C. § 1400(b), in that TK Holdings, Inc. is incorporated and therefore resides in Delaware for purposes of establishing

venue in this district, in that TK Holdings, Inc. has been doing business in Delaware, including the infringing acts alleged herein, both directly, through one or more intermediaries, and/or as an intermediary, and will continue to do so unless enjoined by this Court.

THE PATENTS-IN-SUIT

14. On February 13, 1996, the '690 Patent, entitled "Vehicle Safety Apparatus Including Inflatable Restraint" was duly and legally issued. VSSI is the owner by assignment of all rights, title, and interest in and to the '690 Patent. A copy of the '690 Patent is attached as Exhibit A.

15. On October 22, 1996, the '977 Patent, entitled "Air Bag Including Restraint" was duly and legally issued. VSSI is the owner by assignment of all rights, title, and interest in and to the '977 Patent. A copy of the '977 Patent is attached as Exhibit B.

16. On July 21, 1998, the '489 Patent, entitled "Air Bag With Adhesive At Seams" was duly and legally issued. VSSI is the owner by assignment of all rights, title, and interest in and to the '489 Patent. A copy of the '489 Patent is attached as Exhibit C.

17. On August 10, 1994, the '030 Patent, entitled "Air Bag With Vent" was duly and legally issued. VSSI is the owner by assignment of all rights, title, and interest in and to the '030 Patent. A copy of the '030 Patent is attached as Exhibit D.

18. On April 12, 2005, the '772 Patent, entitled "Air Bag Module With Occupant Engaging Flap" was duly and legally issued. VSSI is the owner by assignment of all rights, title, and interest in and to the '772 Patent. A copy of the '772 Patent is attached as Exhibit E.

19. On September 28, 1999, the '487 Patent, entitled "Lateral Impact Protective Device For Vehicle Occupants" was duly and legally issued. GmbH is the owner by assignment of all rights, title, and interest in and to the '487 Patent. A copy of the '487 Patent is attached as Exhibit F.

20. On December 5, 2000, the '595 Patent, entitled "Knee Protection Device For Vehicle Occupants" was duly and legally issued. GmbH is the owner by assignment of all rights, title, and interest in and to the '595 Patent. A copy of the '595 Patent is attached as Exhibit G.

21. The TRW Companies own the Patents-in-Suit and possess the right to sue and to recover for infringement of the Patents-in-Suit.

22. Defendants have been and are infringing and/or inducing infringement of the Patents-in-Suit because they at least use, cause to be used, make, import, cause to be imported, offer for sale, cause to be offered for sale, sell, and/or cause to be sold in this judicial district and elsewhere in the United States products that infringe the Patents-in-Suit.

FACTUAL BACKGROUND

23. The TRW Companies have invested substantial time and money in designing, developing, manufacturing and producing safety restraint systems and products that incorporate the patented TRW technology.

24. The TRW Companies derive substantial benefits from the exploitation of their patented technology in the United States and abroad. The TRW Companies' interests, including, but not limited to, these benefits have been and continue to be harmed by the Defendants' infringement of the Patents-in-Suit.

25. The Defendants at least use, cause to be used, make, import, cause to be imported, offer for sale, cause to be offered for sale, sell, and/or cause to be sold under the United States and in this judicial district safety restraint systems and products that are encompassed by and/or made by the methods claimed in the Patents-in-Suit.

26. The Defendants have induced and/or continue to induce the infringement of the Patents-in-Suit in the United States and in this judicial district.

27. Defendants maintain and develop relationships with business partners, including, for example, suppliers and customers, to promote and encourage the import, offering for sale, sale and use of its infringing products in the United States.

28. Defendants actively sell to and solicit business from customers and distributors located in the United States. Defendants coordinate with these and other third parties concerning the designs, specifications, distribution and/or placement of orders regarding such products destined for the U.S. market.

29. Defendants also communicate with third parties to promote and encourage the use, sale, importation and/or offering for sale of these same products in and into the United States.

30. Defendants have relationships and meet with third parties about their safety restraint products and these communications and meetings facilitate the sale, offer for sale, and/or distribution of Defendants' products to customers and users in the United States.

COUNT I
INFRINGEMENT OF THE '690 PATENT

31. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

32. Defendants have infringed, and/or induced infringement of the '690 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '690 Patent in this judicial district and elsewhere in the United States.

33. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '690 Patent, either literally or equivalently.

34. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '690 Patent and are without adequate remedy at law.

35. Defendants have, upon information and belief, infringed and are infringing the '690 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT II
INFRINGEMENT OF THE '977 PATENT

36. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

37. Defendants have infringed, and/or induced infringement of the '977 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '977 Patent in this judicial district and elsewhere in the United States.

38. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '977 Patent, either literally or equivalently.

39. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '977 Patent and are without adequate remedy at law.

40. Defendants have, upon information and belief, infringed and are infringing the '977 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT III
INFRINGEMENT OF THE '489 PATENT

41. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

42. Defendants have infringed, and/or induced infringement of the '489 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '489 Patent in this judicial district and elsewhere in the United States.

43. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '489 Patent, either literally or equivalently.

44. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '489 Patent and are without adequate remedy at law.

45. Defendants have, upon information and belief, infringed and are infringing the '489 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT IV
INFRINGEMENT OF THE '030 PATENT

46. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

47. Defendants have infringed, and/or induced infringement of the '030 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '030 Patent in this judicial district and elsewhere in the United States.

48. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '030 Patent, either literally or equivalently.

49. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '030 Patent and are without adequate remedy at law.

50. Defendants have, upon information and belief, infringed and are infringing the '030 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT V
INFRINGEMENT OF THE '772 PATENT

51. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

52. Defendants have infringed, and/or induced infringement of the '772 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '772 Patent in this judicial district and elsewhere in the United States.

53. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '772 Patent, either literally or equivalently.

54. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '772 Patent and are without adequate remedy at law.

55. Defendants have, upon information and belief, infringed and are infringing the '772 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT VI
INFRINGEMENT OF THE '487 PATENT

56. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

57. Defendants have infringed, and/or induced infringement of the '487 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '487 Patent in this judicial district and elsewhere in the United States.

58. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '487 Patent, either literally or equivalently.

59. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '487 Patent and are without adequate remedy at law.

60. Defendants have, upon information and belief, infringed and are infringing the '487 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

COUNT VII
INFRINGEMENT OF THE '595 PATENT

61. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

62. Defendants have infringed, and/or induced infringement of the '595 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '595 Patent in this judicial district and elsewhere in the United States.

63. The products that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '595 Patent, either literally or equivalently.

64. The TRW Companies have been and will continue to be injured by Defendants' past and continuing infringement of the '595 Patent and are without adequate remedy at law.

65. Defendants have, upon information and belief, infringed and are infringing the '595 Patent with knowledge of the TRW Companies' patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling plaintiffs to increased damages and reasonable attorneys' fees pursuant to U.S.C. §§ 284 and 285.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff TRW prays for judgment as follows:

A. That Takata Corporation, TK Holdings, Inc. and Takata-Petri AG have infringed the Patents-in-Suit;

B. That Takata Corporation's, TK Holdings, Inc.'s and Takata-Petri AG's infringement of the Patents-in-Suit has been willful;

C. That Takata Corporation, TK Holdings, Inc. and Takata-Petri AG and their parents, subsidiaries, affiliates, successors, predecessors, assigns, and the officers, directors, agents, servants and employees of each of the foregoing, and those persons acting in concert or participation with any of them, are enjoined and restrained from continued infringement, including but not limited to using, making, importing, offering for sale and/or selling products that infringe, and from inducing the infringement of, the '690 Patent, the '977 Patent, the '489 Patent, the '030 Patent, the '772 Patent, the '487 Patent, and the '595 Patent, prior to their expiration, including any extensions;

D. That Takata Corporation, TK Holdings, Inc. and Takata-Petri AG and their parents, subsidiaries, affiliates, successors, predecessors, assigns, and the officers, directors, agents, servants and employees of each of the foregoing, and those persons acting in concert or participation with any of them deliver to the TRW Companies all products that infringe the Patents-in-Suit for destruction at the TRW Companies' option;

E. That the TRW Companies be awarded monetary relief adequate to compensate them for Defendants' acts of infringement of the Patents-in-Suit, including any extensions;

F. That any monetary relief awarded to the TRW Companies regarding the infringement of the Patents-in-Suit by Defendants be trebled due to the willful nature of Defendants' infringement of the Patents-in-Suit;

H. That this is an exceptional case and that the TRW Companies be awarded the attorneys' fees, costs and expenses that it incurs prosecuting this action; and that the TRW Companies be awarded such other and further relief as this Court deems just and proper.

JURY DEMAND

Plaintiffs demand a trial by jury of any and all issues triable of right by a jury.

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(216) 586-3939

Dated: June 25, 2008
871530

By: /s/ Philip A. Rovner
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provner@potteranderson.com

Attorneys for Plaintiffs

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE**

CERTIFICATE OF SERVICE

I, Philip A. Rovner, hereby certify that on June 25, 2008, the within document was filed with the Clerk of the Court using CM/ECF; that the document was served on the following parties as indicated; and that the document is available for viewing and downloading from CM/ECF.

BY HAND DELIVERY AND E-MAIL

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EXHIBIT A



US005490690A

United States Patent [19][11] **Patent Number:** 5,490,690**Mihm**[45] **Date of Patent:** Feb. 13, 1996[54] **VEHICLE SAFETY APPARATUS INCLUDING INFLATABLE RESTRAINT**[75] **Inventor:** Joseph J. Mihm, North Branch, Mich.[73] **Assignee:** TRW Vehicle Safety Systems Inc.,
Lyndhurst, Ohio

4,988,119	1/1991	Hartmeyer	280/728 A
5,069,480	12/1991	Good	280/728 A
5,088,764	2/1992	Augustitus et al.	
5,217,249	6/1993	Kokeguchi	
5,290,059	3/1994	Smith et al.	
5,346,174	10/1994	Rhein et al.	280/732
5,346,248	9/1994	Rhein et al.	280/732

FOREIGN PATENT DOCUMENTS

5-65048 3/1993 Japan 280/728 A

[21] **Appl. No.:** 273,461[22] **Filed:** Jul. 1, 1994**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 64,039, May 14, 1993, which is a continuation-in-part of Ser. No. 780,260, Oct. 21, 1991, abandoned.

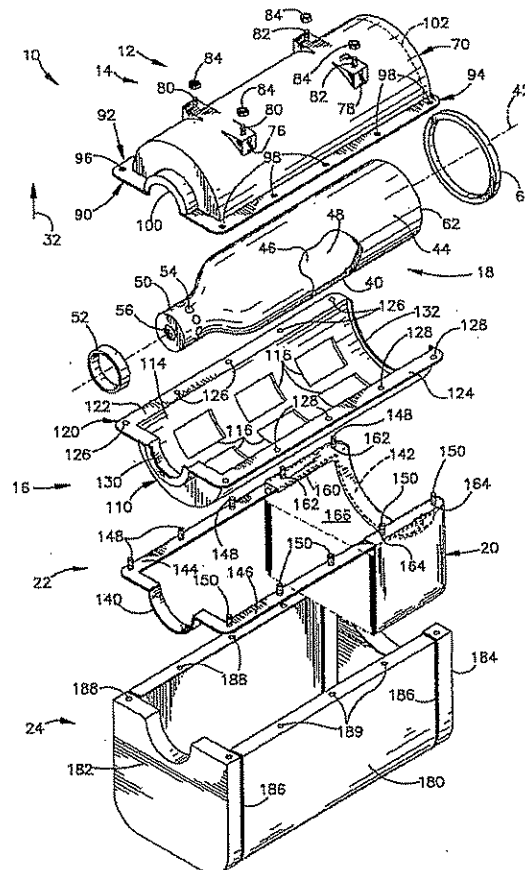
[51] **Int. Cl.⁶** B60R 21/16[52] **U.S. Cl.** 280/728.2; 280/732; 280/740[58] **Field of Search** 280/728 A, 732, 280/730, 728 R, 736, 737, 728.2, 728.1[56] **References Cited****U.S. PATENT DOCUMENTS**

3,871,684	3/1975	Staudacher et al.
4,810,005	3/1989	Fohl
4,915,410	4/1990	Bachelder

Primary Examiner—Karin L. Tyson
Attorney, Agent, or Firm—Tarolli, Sundheim & Covell

[57] **ABSTRACT**

An air bag module 10 includes an inflator (18) clamped between a first portion (14) and a second portion (16) of a housing (12). An air bag (20) is connected with a retaining ring (22). A series of fasteners (148, 150) on the retaining ring (22) extend through fastener openings (162, 164) in the air bag (20) and through fastener openings (96, 98) in the first portion (14) of the housing (12) and through fastener openings (126, 128) in the second portion (16) of the housing (12). The fasteners (148, 150) connect the air bag (20) with the retaining ring (22) and with the first and second portions (14, 16) of the housing (12).

24 Claims, 5 Drawing Sheets

U.S. Patent

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Sheet 1 of 5

5,490,690

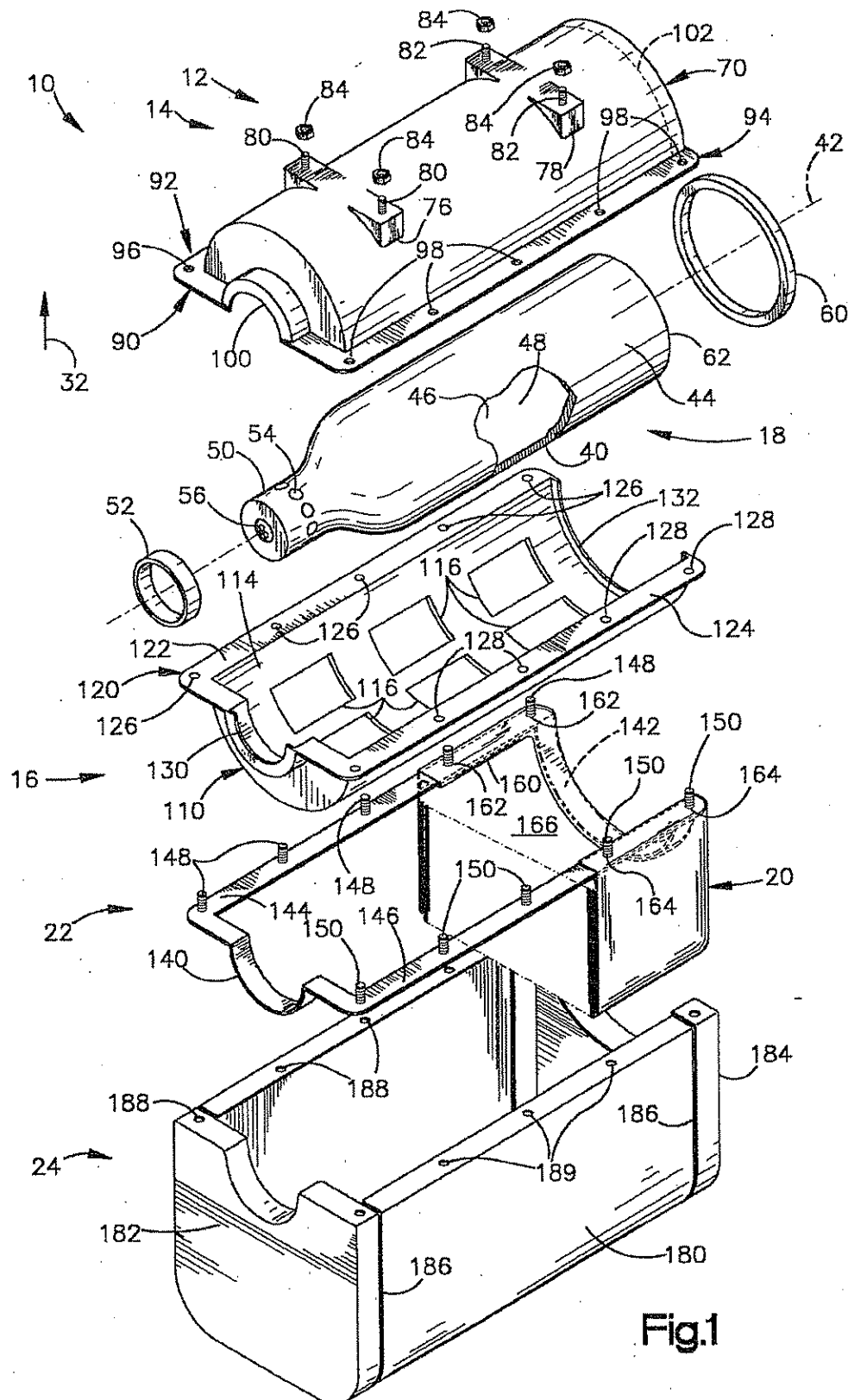


Fig.1

U.S. Patent

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5,490,690

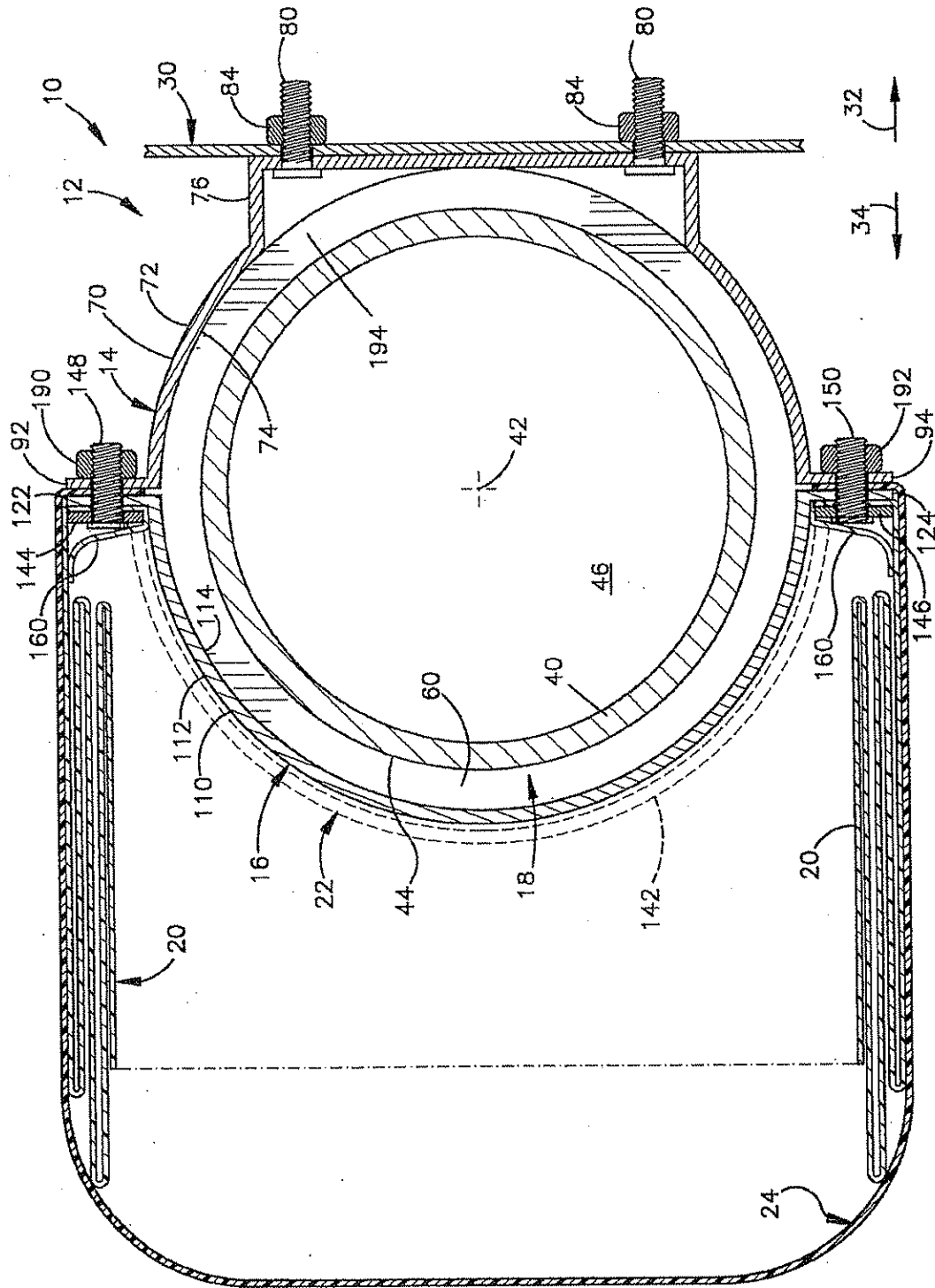


Fig.2

U.S. Patent

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5,490,690

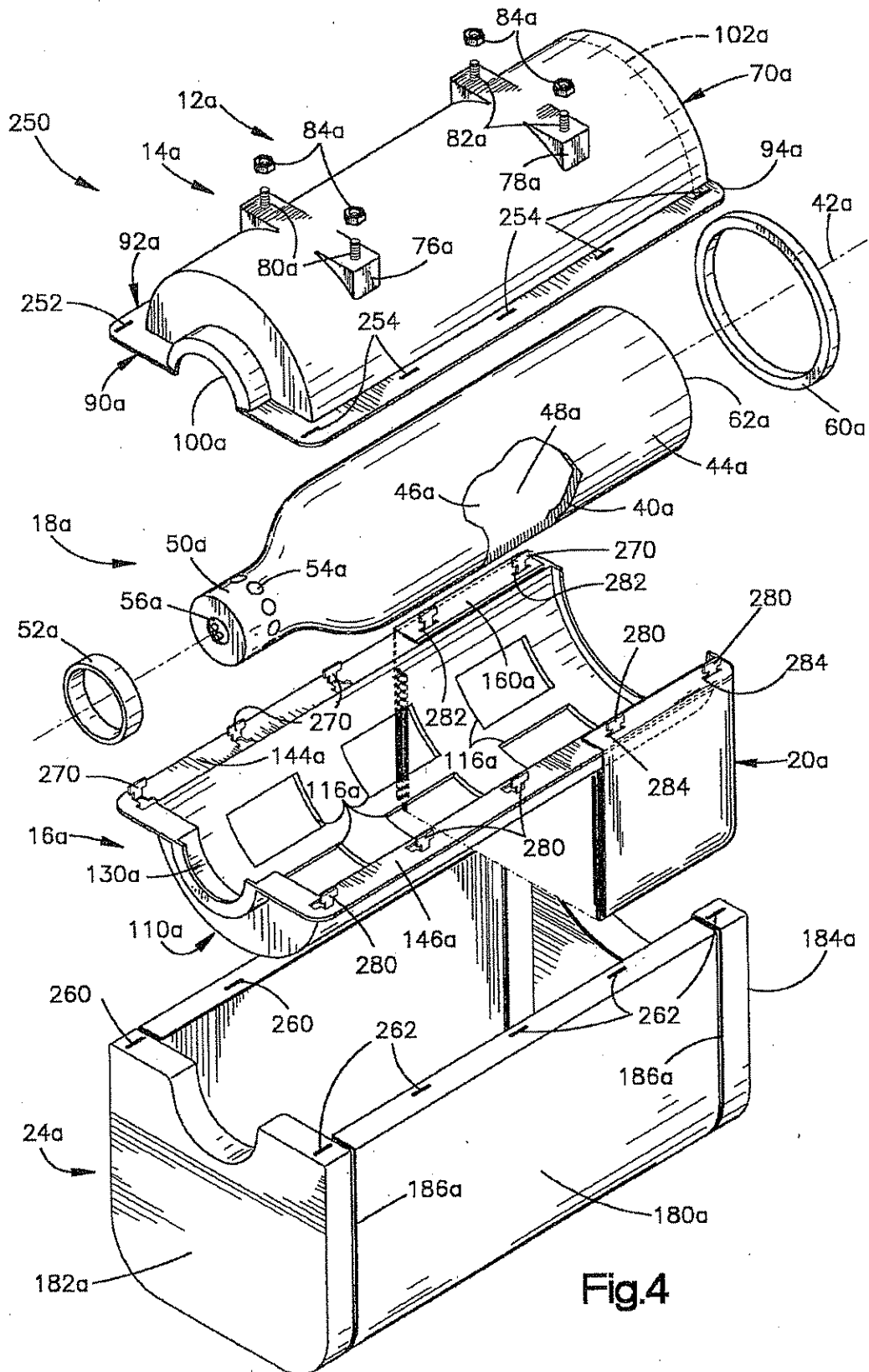


Fig.4

U.S. Patent

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Sheet 4 of 5

5,490,690

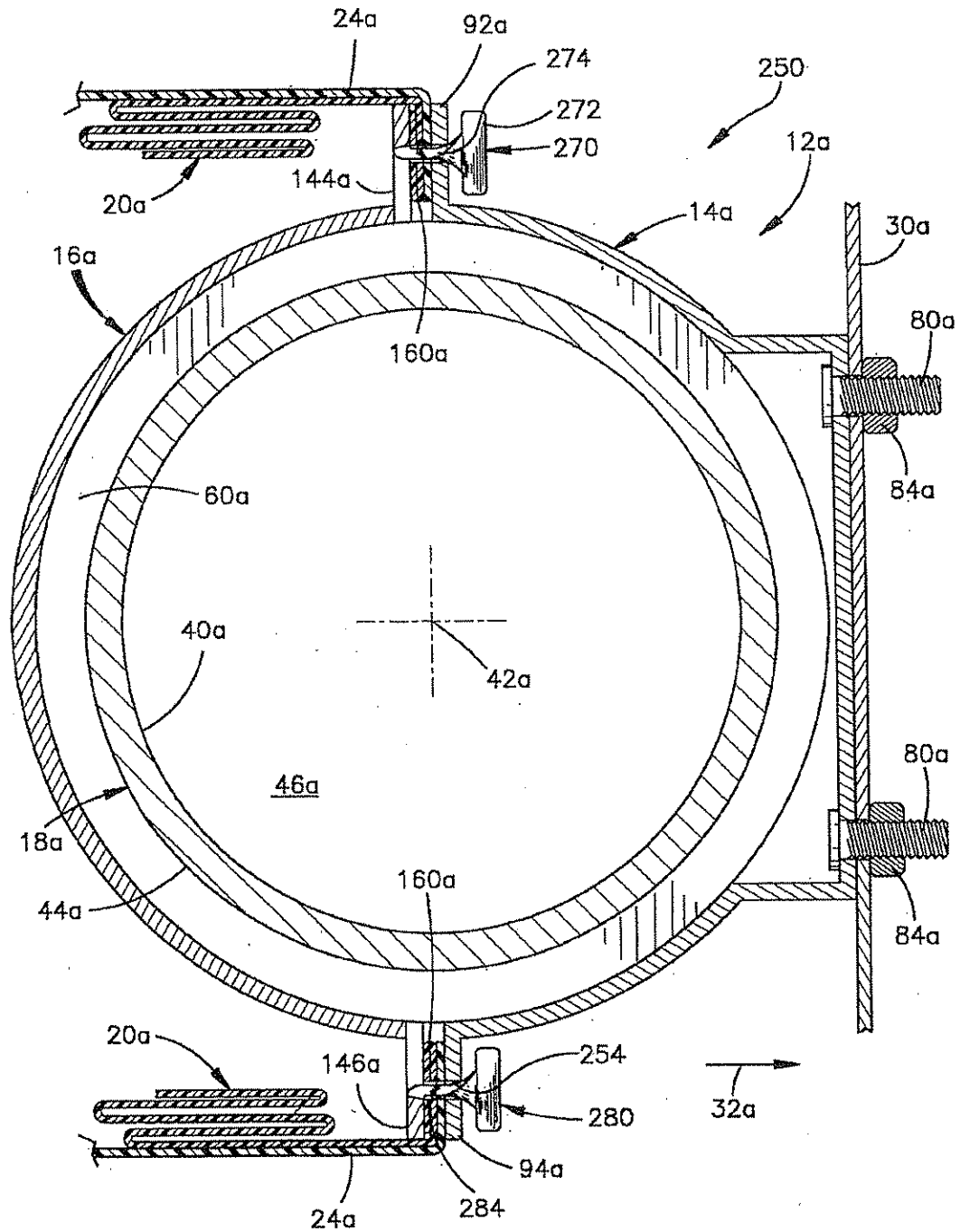


Fig.5

U.S. Patent

Feb. 13, 1996

Sheet 5 of 5

5,490,690

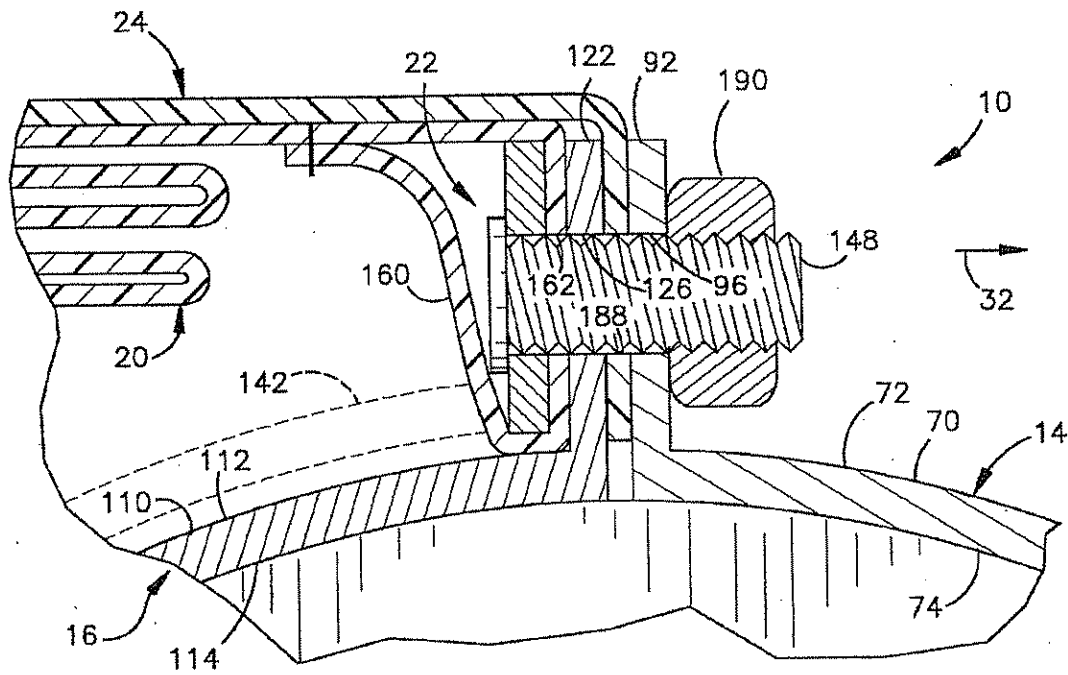


Fig.3

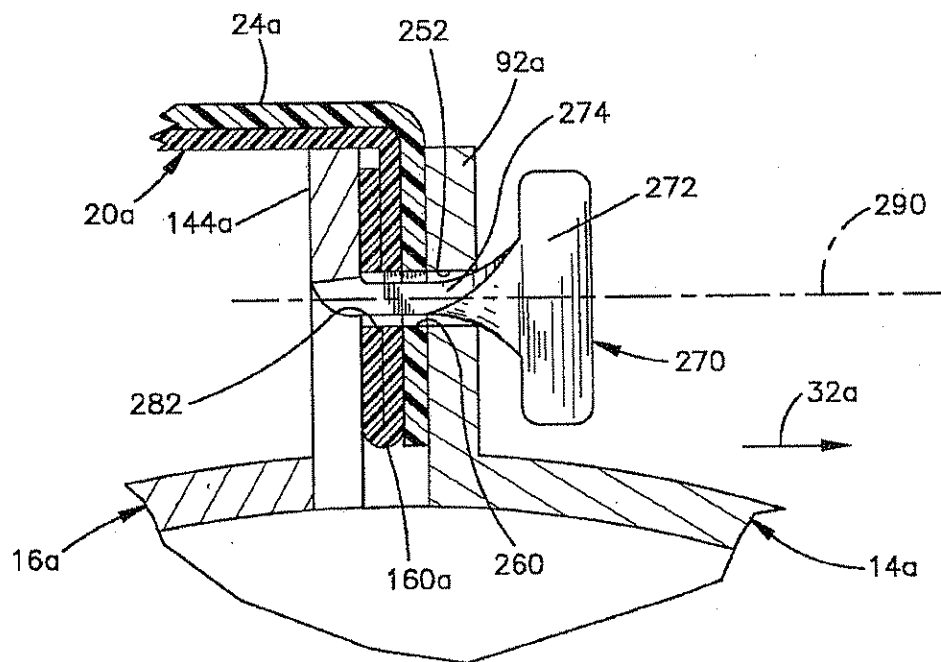


Fig.6

5,490,690

1

VEHICLE SAFETY APPARATUS INCLUDING INFLATABLE RESTRAINT

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 08/064,039 filed May 14, 1993, entitled "AIRBAG ASSEMBLY"; which is a continuation-in-part of U.S. patent application Ser. No. 07/780,260 filed Oct. 21, 1991, now abandoned entitled "AIR BAG REACTION CAN STRUCTURE AND METHOD OF ASSEMBLY".

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a vehicle safety apparatus including an inflatable vehicle occupant restraint, and particularly relates to an air bag module including an inflator housing having separate portions which are connected by a plurality of fasteners.

2. Description of the Prior Art

A typical air bag module includes an air bag, an inflator for inflating the air bag, and a housing in which the air bag and the inflator are disposed. The housing is connected with a portion of the vehicle such as the vehicle instrument panel and supports the air bag and the inflator in the vehicle. In the event of a vehicle collision, the inflator is actuated to direct inflation fluid into the air bag. The air bag inflates into a position to restrain the vehicle occupant from forcefully striking parts of the vehicle.

It is known to form the housing of two or more separate parts which are secured together. It is also known to connect the air bag to a retaining ring and to secure the retaining ring to the housing.

SUMMARY OF THE INVENTION

The present invention is a vehicle safety apparatus comprising a housing including a first portion and a second portion which define a first chamber in the housing. At least one of the first and second portions has a series of fastener openings. An inflator is disposed in the first chamber between the first and second portions of the housing. The inflator includes a wall defining a second chamber in the inflator. An inflation fluid source is disposed in the second chamber in the inflator. The inflator wall has an outer surface extending between first and second opposite end portions of the inflator. The first portion of the housing and the second portion of the housing clamp the outer surface of the inflator wall and clamp the first and second end portions of the inflator. The vehicle safety apparatus includes an inflatable vehicle occupant restraint having an inflation fluid opening and a series of fastener openings. A plurality of fasteners extend through the fastener openings in the at least one portion of the housing and through the fastener openings in the inflatable restraint. The fasteners connect the first portion of the housing with the second portion of the housing and with the inflatable restraint.

In one embodiment of the invention, both the first portion of the housing and the second portion of the housing have a respective series of fastener openings. The fasteners are disposed on a retaining ring with which the inflatable restraint is connected. The fasteners on the retaining ring extend through the fastener openings in the first portion of the housing and through the fastener openings in the second

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portion of the housing and through the fastener openings in the inflatable restraint.

In another embodiment of the invention, the first portion of the housing includes the series of fastener openings, and the plurality of fasteners are disposed on the second portion of the housing. The inflatable restraint is connected with the second portion of the housing. The fasteners on the second portion of the housing extend through the fastener openings in the inflatable restraint and through the fastener openings in the first portion of the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features of the present invention will become apparent to those skilled in the art to which the present invention relates from reading the following specification with reference to the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of an air bag module which is constructed in accordance with a first embodiment of the present invention;

FIG. 2 is a sectional view of the air bag module of FIG. 1;

FIG. 3 is an enlarged view of a portion of FIG. 2;

FIG. 4 is an exploded perspective view of an air bag module which is constructed in accordance with a second embodiment of the present invention;

FIG. 5 is a sectional view of the air bag module of FIG. 4; and

FIG. 6 is an enlarged view of a portion of FIG. 5.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

The present invention relates to a vehicle safety apparatus including an inflatable vehicle occupant restraint. The present invention is applicable to various vehicle safety apparatus constructions. As representative of the present invention, FIG. 1 illustrates a vehicle safety apparatus or air bag module 10.

The air bag module 10 includes a housing 12 comprising a first portion 14 and a second portion 16. The module 10 also includes an inflator 18, an air bag 20, a retaining ring 22, and a cover 24. The module 10 is secured to a portion of a vehicle indicated at 30 (FIG. 2). The forward direction of travel of the vehicle is indicated by arrow 32 in FIG. 2, whereas arrow 34 in FIG. 2 indicates the rearward direction of vehicle travel. The parts of the module 10 are disposed in the vehicle in an orientation as illustrated in FIG. 2 with the inflator 18 disposed forward of the folded air bag 20.

The inflator 18 (FIGS. 1 and 2) has a generally elongate cylindrical configuration. A tubular wall 40 of the inflator 18 extends around a longitudinal central axis 42 of the module 10. The inflator wall 40 has a cylindrical outer surface 44 which extends between opposite end portions 50 and 62 of the inflator 18. The inflator wall 40 defines in the inflator 18 an inflation fluid chamber 46 within which is disposed a known inflation fluid 48 (FIG. 1). The inflation fluid 48 is a quantity of gas which is stored under pressure in the inflator 18 along with an ignitable material. Alternatively, the inflator 18 could contain a stored gas only or only a pyrotechnic gas generating material.

The housing 12 includes first and second annular elastomeric seal pads 52 and 60 (FIG. 1) which are disposed intermediate the housing portions 14 and 16. The seal pad 52 extends circumferentially around the outer surface 44 of the inflator wall 40 at the first end portion 50 of the inflator 18.

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The seal pad 60 extends circumferentially around the outer surface 44 of the inflator wall 40 at the second end portion 62 of the inflator 18.

A circular array of inflation fluid outlets 54 is formed on the first end portion 50 of the inflator 18 at a location adjacent to and axially inward of the seal pad 52. An electrical connector 56 which may include a pair of lead wires is disposed on the end of the inflator 18. The connector 56 is electrically connected in a known manner with electric circuitry (not shown) of the vehicle 30, for receiving an electric current to actuate the inflator 18.

The first portion 14 of the housing 12 (FIGS. 1 and 2) has a clam shell configuration. The first portion 14 of the housing 12 includes a main body portion 70 having a generally cylindrical outer surface 72 and a generally cylindrical inner surface 74. A pair of axially spaced fastener supports 76 and 78 project forward from the main body portion 70. A pair of threaded studs 80 are welded to the fastener support 76 and a pair of threaded studs 82 are welded to the fastener support 78. The threaded studs 80 and 82 extend through openings in the vehicle portion 30. Nuts 84 are screwed on the threaded studs 80 and 82 to secure the first portion 14 of the housing 12 to the vehicle portion 30.

The first portion 14 of the housing 12 has an outer peripheral flange 90 (FIG. 1) which extends radially outward from the main body portion 70. The flange 90 includes upper (as viewed in FIG. 2) and lower planar portions 92 and 94. A series of axially spaced circular fastener openings 96 (FIGS. 1 and 3) is formed in the upper flange portion 92. Another series of axially spaced circular fastener openings 98 (FIG. 1) is formed in the lower flange portion 94 of the first portion 14 of the housing 12.

A first clamping portion 100 (FIG. 1) of the flange 90 is disposed at one axial end of the first portion 14 of the housing 12. The first clamping portion 90 is configured generally as an arc of a circle centered on the axis 42. A second clamping portion 102 of the flange 90 is disposed at the opposite axial end of the first portion 14 of the housing 12. The second clamping portion 102 is configured generally as an arc of a circle centered on the axis 42. The clamping portions 100 and 102 receive the annular seal pads 52 and 60, respectively, when the air bag module 10 is in the assembled condition illustrated in FIG. 2.

The second portion 16 of the housing 12 is generally similar in overall configuration to the first portion 14 of the housing. The second portion 16 of the housing 12 has a clam shell configuration as best seen in FIG. 1. The second portion 16 of the housing 12 includes a main body portion 110 having a cylindrical outer surface 112 (FIG. 2) and a cylindrical inner surface 114. A series of diffuser openings 116 (FIG. 1) extend through the main body portion 110 between the outer and inner surfaces 112 and 114.

The second portion 16 of the housing 12 has an outer peripheral flange 120 which extends radially outward from the main body portion 110. The flange 120 includes planar upper and lower (as viewed in FIG. 1) portions 122 and 124. A series of axially spaced circular fastener openings 126 is formed in the flange portion 122. A series of axially spaced circular fastener openings 128 is formed in the flange portion 124.

A first clamping portion 130 (FIG. 1) of the flange 120 is disposed at one axial end of the second portion 16 of the housing 12. The clamping portion 130 is configured generally as an arc of a circle centered on the axis 42. The clamping portion 130 receives the first seal pad 52 when the air bag module 10 is in the assembled condition illustrated

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in FIG. 2. A second clamping portion 132 is disposed at the opposite axial end of the housing portion 16. The second clamping portion 132 is configured generally as an arc of a circle centered on the axis 42. The clamping portion 132 receives the second seal pad 60 when the air bag module 10 is in the assembled condition illustrated in FIG. 2.

The retaining ring 22 (FIGS. 1 and 2) is similar in overall configuration to the flange 120 of the second portion 16 of the housing 12. The retaining ring 22 has an arcuate first end portion 140 which is configured generally as an arc of a circle centered approximately on the axis 42. The first end portion 140 of the retaining ring 22 overlies the arcuate first clamping portion 130 of the second portion 16 of the housing 12. The first end portion 140 of the retaining ring 22 is disposed radially outward of the first seal pad 52 and the first end portion 50 of the inflator 18. An arcuate second end portion 142 of the retaining ring 22 overlies the arcuate second clamping portion 132 of the second portion 16 of the housing 12. The second end portion 142 of the retaining ring 22 is configured generally as an arc of a circle centered approximately on the axis 42. The second end portion 142 of the retaining ring 22 is disposed radially outward of the seal pad 60 and the second end portion 62 of the inflator 18.

The retaining ring 22 includes parallel planar upper and lower (as viewed in FIG. 1) portions 144 and 146 which extend axially between the arcuate end portions 140 and 142. A series of fasteners 148 is disposed on the upper portion 144 of the retaining ring 22. The fasteners 148 are cylindrical externally threaded studs which are welded or otherwise fastened to the upper portion 144 of the retaining ring 22. The fasteners 148 project forward in the direction indicated by the arrow 32 from the upper portion 144 of the retaining ring. The fasteners 148 are spaced apart axially along the retaining ring 22 so as to align with the fastener openings 126 in the second portion 16 of the housing 12 and the fastener openings 96 in the first portion 14 of the housing.

A series of fasteners 150 is disposed on the lower portion 146 of the retaining ring 22. The fasteners 150 are identical to the fasteners 148. The fasteners 150 project forward in the direction indicated by the arrow 32 (FIG. 2) from the lower portion 146 of the retaining ring 22. The fasteners 150 are spaced apart axially along the retaining ring 22 so as to align with the fastener openings 128 in the second portion 16 of the housing 12 and the fastener openings 98 in the first portion 14 of the housing.

The air bag 20 (FIGS. 1 and 2) is made from a fabric material, preferably woven nylon. An attachment portion 160 of the air bag 20 is wrapped around the retaining ring 22 and sewn to secure the air bag to the retaining ring. Two rows of axially spaced circular fastener openings 162 (FIGS. 1 and 3) and 164 (FIG. 1) are formed in the attachment portion 160 of the air bag 20.

The cover 24 (FIGS. 1 and 2) is made from a thin paper or plastic material, preferably TYVEK® brand flexible polyethylene sheet material which is available from E. I. DuPont de Nemours & Co. of Delaware. The cover 24 includes a central portion 180 and opposite end portions 182 and 184. A plurality of gaps 186 allow for the cover 24 to be wrapped tightly around the folded air bag 20. Two rows of axially spaced circular fastener openings 188 and 189 are formed in the cover 24.

In assembly of the air bag module 10, the attachment portion 160 of the air bag 20 is wrapped around the retaining ring 22 in a manner such that the fasteners 148 and 150 on the retaining ring extend through the fastener openings 162

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and 164, respectively, in the air bag. The attachment portion 160 of the air bag 20 is sewn to secure the air bag to the retaining ring 22. The air bag 20 is folded in a known manner so as to define an inflation fluid opening 166 through which inflation fluid can be directed from the inflator 18.

The housing portions 14 and 16, the seals 52 and 60, the inflator 18, and the cover 24 are then secured by the fasteners 148 and 150 to the assembly of the air bag 20 and retaining ring 22. The fasteners 148 (FIG. 3) on the upper portion 144 of the retaining ring 22 extend through the fastener openings 162 in the air bag 20 and through the fastener openings 126 in the upper flange portion 122 of the second portion 16 of the housing 12. The fasteners 148 also extend through the fastener openings 188 in the cover 24 and through the fastener openings 96 in the upper flange portion 92 of the first portion 14 of the housing. A plurality of nuts 190 (FIG. 2) are screwed on the fasteners 148. The fasteners 150 (FIGS. 1 and 2) extend through the fastener openings 164 in the air bag 20 and through the fastener openings 128 in the lower flange portion 124 of the second portion 16 of the housing 12. The fasteners 150 also extend through the fastener openings 189 in the cover 24 and through the fastener openings 98 in the lower flange portion 94 of the second portion 14 of the housing. A plurality of nuts 192 (FIG. 2) are screwed on the lower fasteners 150.

The seal pads 52 and 60 (FIG. 1) are clamped between the first and second housing portions 14 and 16. The housing portions 12 and 14, acting through the seal pads 52 and 60, clamp the outer surface 44 of the inflator wall 40 at the inflator end portions 50 and 62. The inflator 18 is thus clamped in the housing 12 in a diffuser chamber 194 (FIG. 2) between the housing portions 14 and 16. The chamber 194 is an annular gap between the inflator 18 and the housing 12 which gap extends between the seal pads 52 and 60. The retaining ring 22, with the air bag 20 connected thereto, is clamped against the flange 120 of the second portion 16 of the housing 12. The cover 24 is wrapped tightly around the air bag 20 to keep the air bag in its folded and stored condition. The assembled air bag module 10 is secured to the vehicle 30 (FIG. 2) by the studs 80 and 82 and the nuts 84.

In the event of a vehicle collision, a collision sensor in the electric circuitry (not shown) of the vehicle causes an electric current to flow through the electrical connector 56 to actuate the inflator 18. Inflation fluid is directed from the inflator 18 through the inflation fluid outlets 54 into the diffuser chamber 194 between the inflator 18 and the housing 12. The inflation fluid flows around the inflator 18 and along the length of the inflator. The inflation fluid exits the chamber 194 through the diffuser openings 116 in the second portion 16 of the housing 12 and passes through the inflation fluid opening 166 into the air bag 20. The air bag 20 inflates from the folded and stored condition shown in FIG. 2 to an unfolded and inflated condition (not shown). As the air bag 20 inflates, it ruptures the cover 24. The inflating air bag 20 also displaces or opens another cover (not shown) which forms a part of the vehicle visible to an occupant and which is made of a relatively rigid material to protect the air bag when the module 10 is mounted in the vehicle 30. The air bag 20 inflates into a position in the vehicle to restrain a vehicle occupant.

FIGS. 4-6 illustrate a vehicle safety apparatus or air bag module 250 which is constructed in accordance with a second embodiment of the present invention. The air bag module 250 is generally similar to the air bag module 10 (FIGS. 1-3). Thus, parts and elements in FIGS. 4-6 which are the same as or similar to corresponding parts and elements in FIGS. 1-3 are given the same reference numeral with the suffix "a" attached.

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The air bag module 250 (FIGS. 4-6) includes a housing 12a having a first portion 14a and a second portion 16a. The first portion 14a of the housing 12a is generally similar to the first portion 14 (FIGS. 1-3) of the air bag module 10. However, in place of the circular fastener openings 96 and 98 in the housing portion 14, the housing portion 14a (FIG. 4) includes fastener openings which are configured as elongate slots 252, 254. A series of axially extending elongate slots 252 (FIGS. 4 and 6) is formed in the upper flange portion 92a of the first portion 14a of the housing 12a. A series of axially extending elongate slots 254 (FIGS. 4 and 5) is formed in the lower flange portion 94a of the first portion 14a of the housing 12a. The cover 24a (FIG. 4) also includes two rows of elongate slots 260 and 262 instead of circular fastener openings.

The air bag 20a includes an attachment portion 160a (FIGS. 4 and 6) which is configured as a double layered, folded over edge portion of the air bag. The attachment portion 160a overlies the upper and lower flange portions 144a and 146a (FIG. 4) of the second portion 16a of the housing 12a. Two rows of axially spaced fastener openings 282 and 284, which are configured as elongate slots are formed in the attachment portion 160a of the air bag 20a.

The air bag module 250 does not include a separate retaining ring such as the retaining ring 22 (FIG. 1) with threaded studs 148 and 150. Instead, a series of twist tabs 270 (FIG. 4) is formed on the upper flange portion 144a of the second portion 16a of the housing 12a. Each twist tab 270 is bent out of the material of the upper flange portion 144a and includes a flat elongate head portion 272 (FIGS. 5 and 6) supported on a relatively narrow neck portion 274. The twist tabs 270 project forward from the second portion 16a of the housing 12a in a direction 32a toward the first portion 14a of the housing.

Another series of twist tabs 280 (FIGS. 4 and 5) is formed on the lower flange portion 146a of the second portion 16a of the housing 12a. The twist tabs 280 are identical in construction to the twist tabs 270. The twist tabs 280 are bent out of the material of the lower flange portion 146a of the second portion 16a of the housing 12a. The twist tabs 280 project from the second portion 16a of the housing 12a in the direction 32a toward the first portion 14a of the housing.

The twist tabs 270 (FIG. 6) on the upper flange portion 144a of the second portion 16a of the housing 12a extend through the slots 282 in the attachment portion 160a of the air bag 20a. The twist tabs 270 also extend through the slots 260 in the cover 24a and through the slots 252 in the flange portion 92a of the first portion 14a of the housing 12a. (FIG. 6 is taken through slots 282, 260, and 252, but not through the twist tab 270 itself, so as to show more clearly the formation of the twist tab.) The twist tabs 280 (FIG. 5) on the lower flange portion 146a of the second portion 16a of the housing 12a extend through the slots 284 in the attachment portion 160a of the air bag 20a. The twist tabs 280 also extend through the slots 262 (FIG. 4) in the cover 24a and through the slots 254 (FIG. 5) in the first portion 14a of the housing 12a.

To secure the parts of the air bag module 250 in the assembled condition shown in FIGS. 5 and 6, the head portion 272 of each twist tab 270 (FIG. 6) is rotated about an axis 290 extending through the neck portion 274. The neck portion 274 of each twist tab 270 deforms to allow rotation of the head portion 272 relative to the second portion 16a of the housing 12a. The head portion 272 of each twist tab 270 is rotated by a sufficient amount, in the range of from about 10° to about 90°, so as to block

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movement of the head portion 272 through the slot 252 in the flange 92a of the first portion 14a of the housing 12a. In a similar manner, the head portions of the lower twist tabs 280 (FIG. 5) are rotated so as to block movement of the twist tabs 280 through the slots 254 in the lower flange portion 94a of the first portion 14a of the housing 12a.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications in the invention. For example, the threaded studs 148 and 150 on the retaining ring 22 (FIGS. 1-3) could be replaced with other types of fasteners such as the twist tabs 270 and 280 (FIGS. 4-6). The twist tabs 270 and 280 on the second portion 16a of the housing 12a (FIGS. 4-6) could be replaced with other types of fasteners such as the threaded studs 148 and 150 (FIGS. 1-3). Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

Having described the invention, I claim:

1. A vehicle safety apparatus comprising:

a housing including a first portion and a second portion which define a first chamber in said housing, at least one of said first and second portions having a series of fastener openings;
said first portion of said housing having first and second opposite end portions and said second portion of said housing having first and second opposite end portions;
an inflator disposed in said first chamber between said first and second portions of said housing, said inflator including a wall defining a second chamber in said inflator, an inflation fluid source disposed in said second chamber in said inflator, said inflator wall having an outer surface extending between first and second opposite end portions of said inflator;
said first end portion of said inflator being clamped with said first end portion of said first housing portion and said first end portion of said second housing portion, said second end portion of said inflator being clamped with said second end portion of said first housing portion and said second end portion of said second housing portion;
an inflatable vehicle occupant restraint having an inflation fluid opening and a series of fastener openings; and
a plurality of fasteners extending through said fastener openings in said at least one portion of said housing and through said fastener openings in said inflatable restraint, said fasteners connecting said first portion of said housing with said second portion of said housing and with said inflatable restraint.

2. An apparatus as set forth in claim 1 wherein each of said first and second portions of said housing includes a respective series of fastener openings; said plurality of fasteners extending through said fastener openings in said first portion of said housing and through said fastener openings in said second portion of said housing and through said fastener openings in said inflatable restraint.

3. An apparatus as set forth in claim 2 further comprising a retaining ring connected with said inflatable restraint, said inflatable restraint being secured to said retaining ring, said fasteners projecting in a direction away from said retaining ring through said fastener openings in said first portion of said housing and through said fastener openings in said second portion of said housing and through said fastener openings in said inflatable restraint.

4. An apparatus as set forth in claim 3 wherein:
said first portion of said housing comprises a clam shell shaped main body portion and a radial flange extending

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around the outer periphery of said body portion, said series of fastener openings in said first portion of said housing being formed in said flange; and

said second portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said series of fastener openings in said second portion of said housing being formed in said flange on said second portion of said housing.

5. An apparatus as set forth in claim 3 wherein said first portion of said housing includes said series of fastener openings and said second portion of said housing includes said plurality of fasteners, said plurality of fasteners on said second portion of said housing extending through said fastener openings in said first portion of said housing and through said fastener openings in said inflatable restraint, said fasteners connecting said second portion of said housing with said first portion of said housing and with said inflatable restraint.

6. An apparatus as set forth in claim 5 wherein:

said first portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said series of fastener openings in said first portion of said housing being formed in said flange of said first portion of said housing; and

said second portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said plurality of fasteners on said second portion of said housing being disposed on said flange of said second portion of said housing and projecting from said flange of said second portion of said housing.

7. An apparatus as set forth in claim 1 wherein said first portion of said housing includes mounting means for mounting said vehicle safety apparatus on a vehicle, said mounting means comprising a plurality of mounting members fixed to said first portion of said housing and projecting from said first portion of said housing in a direction away from said second portion of said housing, said mounting members being engageable with a portion of a vehicle to mount said vehicle safety apparatus on a vehicle.

8. An apparatus as set forth in claim 1 wherein said first portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said series of fastener openings being formed in said flange of said first portion of said housing;

said second portion of said housing comprising a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion;

said plurality of fasteners extending through said fastener openings in said outer peripheral flange of said first portion of said housing and through said fastener openings in said inflatable restraint;

said inflator wall being generally cylindrical in configuration and extending about a longitudinal central axis of said inflator;

said first end portion of said first portion of said housing being configured as an arc of a circle centered on said axis and clamping said first end portion of said inflator, and said second end portion of said first portion of said housing being configured as an arc of a circle centered on said axis and clamping said second end portion of said inflator;

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said first end portion of said second portion of said housing being configured as an arc of a circle centered on said axis and clamping said first end portion of said inflator, and said second end portion of said second portion of said housing being configured as an arc of a circle centered on said axis and clamping said second end portion of said inflator.

9. An apparatus as set forth in claim 1 wherein said fasteners comprise threaded studs.

10. An apparatus as set forth in claim 1 wherein said plurality of fasteners comprises a plurality of twist tabs on said second portion of said housing.

11. A vehicle safety apparatus comprising:

a housing including a first portion and a second portion which define a first chamber in said housing, said first portion and said second portion each having a series of fastener openings;

said first portion of said housing having first and second opposite end portions and said second portion of said housing having first and second opposite end portions; an inflator disposed in said first chamber between said first and second portions of said housing, said inflator including a wall defining a second chamber in said inflator, an inflation fluid source disposed in said second chamber in said inflator, said inflator wall having an outer surface extending between first and second opposite end portions of said inflator;

said first end portion of said inflator being clamped with said first end portion of said first housing portion and said first end portion of said second housing portion, said second end portion of said inflator being clamped with said second end portion of said first housing portion and said second end portion of said second housing portion;

an inflatable vehicle occupant restraint having an inflation fluid opening and a series of fastener openings; and a plurality of fasteners extending through said fastener openings in said first portion of said housing and through said fastener openings in said second portion of said housing and through said fastener openings in said inflatable restraint, said fasteners connecting said first portion of said housing with said second portion of said housing and with said inflatable restraint.

12. An apparatus as set forth in claim 11 further comprising a retaining ring connected with said inflatable restraint, said inflatable restraint being secured to said retaining ring, said fasteners projecting in a direction away from said retaining ring through said fastener openings in said first portion of said housing and through said fastener openings in said second portion of said housing and through said fastener openings in said inflatable restraint.

13. An apparatus as set forth in claim 12 wherein:

said first portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said series of fastener openings in said first portion of said housing being formed in said flange of said first portion of said housing; and

said second portion of said housing comprises a clam shell shaped main body portion and a radial flange extending around the outer periphery of said body portion, said series of fastener openings in said second portion of said housing being formed in said flange of said second portion of said housing.

14. An apparatus as set forth in claim 13 wherein:

said inflator wall is cylindrical in configuration and extends about a longitudinal central axis of said inflator;

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said first end portion of said first portion of said housing being configured as an arc of a circle centered on said axis and clamping said first end portion of said inflator and said second end portion of said first portion of said housing being configured as an arc of a circle centered on said axis and clamping said second end portion of said inflator; and

said first end portion of said second portion of said housing being configured as an arc of a circle centered on said axis and clamping said first end portion of said inflator and said second end portion of said second portion of said housing being configured as an arc of a circle centered on said axis and clamping said second end portion of said inflator.

15. An apparatus as set forth in claim 14 wherein said first portion of said housing includes mounting means for mounting said vehicle safety apparatus on a vehicle, said mounting means comprising a plurality of mounting members fixed to said main body portion of said first portion of said housing and projecting from said main body portion of said first portion of said housing in a direction away from said second portion of said housing, said mounting members being engageable with a portion of a vehicle to support said vehicle safety apparatus on a vehicle.

16. An apparatus as set forth in claim 10 wherein each one of said twist tabs includes a flat elongate head portion supported on a relatively narrow neck portion associated with said head portion;

said twist tabs projecting from said second portion of said housing in a direction toward said first portion of said housing;

said fastener openings in said at least one portion of said housing comprising fastener openings in said first portion of said housing;

said twist tabs extending through said fastener openings in said inflatable restraint and through said fastener openings in said first portion of said housing;

each one of said head portions of said twist tabs being rotated about a respective axis extending through a respective associated neck portion, said neck portions of said twist tabs deforming to allow rotation of said head portions relative to said second portion of said housing.

17. An apparatus as set forth in claim 16 wherein said head portions of said twist tabs are rotated relative to said neck portions by a sufficient amount so as to block movement of said head portions through said fastener openings in said first portion of said housing.

18. An apparatus as set forth in claim 17 wherein said head portions of said twist tabs are rotated relative to said neck portions by an amount in the range of from about 10° to about 90°.

19. An apparatus as set forth in claim 16 wherein said twist tabs are bent out of the material of said second portion of said housing.

20. A vehicle safety apparatus comprising:

a housing including a first portion and a second portion which define a first chamber in said housing, said first portion of said housing having a series of fastener openings;

said first portion of said housing having first and second opposite end portions and said second portion of said housing having first and second opposite end portions;

an inflator disposed in said first chamber between said first and second portions of said housing, said inflator including a wall defining a second chamber in said

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inflator, an inflation fluid source disposed in said second chamber in said inflator, said inflator wall having an outer surface extending between first and second opposite end portions of said inflator;

said first end portion of said inflator being clamped with said first end portion of said first housing portion and said first end portion of said second housing portion, and said second end portion of said inflator being clamped with said second end portion of said first housing portion and said second end portion of said second housing portion;

an inflatable vehicle occupant restraint having an inflation fluid opening and a series of fastener openings; and

a plurality of twist tabs on said second portion of said housing, said twist tabs extending through said fastener openings in said first portion of said housing and through said fastener openings in said inflatable restraint, said twist connecting said first portion of said housing with said second portion of said housing and with said inflatable restraint.

21. An apparatus as set forth in claim 20 wherein each one of said twist tabs includes a flat elongate head portion supported on a relatively narrow neck portion associated with said head portion;

said twist tabs projecting from said second portion of said housing in a direction toward said first portion of said housing;

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said twist tabs extending through said fastener openings in said inflatable restraint and through said fastener openings in said first portion of said housing;

each one of said head portions of said twist tabs being rotated about a respective axis extending through a respective associated neck portion, said neck portions of said twist tabs deforming to allow rotation of said head portions relative to said second portion of said housing.

22. An apparatus as set forth in claim 21 wherein said head portions of said twist tabs are rotated relative to said neck portions by a sufficient amount so as to block movement of said head portions through said fastener openings in said first portion of said housing.

23. An apparatus as set forth in claim 22 wherein said head portions of said twist tabs are rotated relative to said neck portions by an amount in the range of from about 10° to about 90°.

24. An apparatus as set forth in claim 20 wherein said twist tabs are bent out of the material of said second portion of said housing.

* * * * *

EXHIBIT B



US005566977A

United States Patent [19]
Wipasuramonton

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[45] **Date of Patent:** Oct. 22, 1996

[54] AIR BAG INCLUDING RESTRAINT

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[52] U.S. Cl. 280/743.1; 280/730.2

[58] Field of Search 280/728.1, 730.1,
280/730.2, 743.1; 5/458

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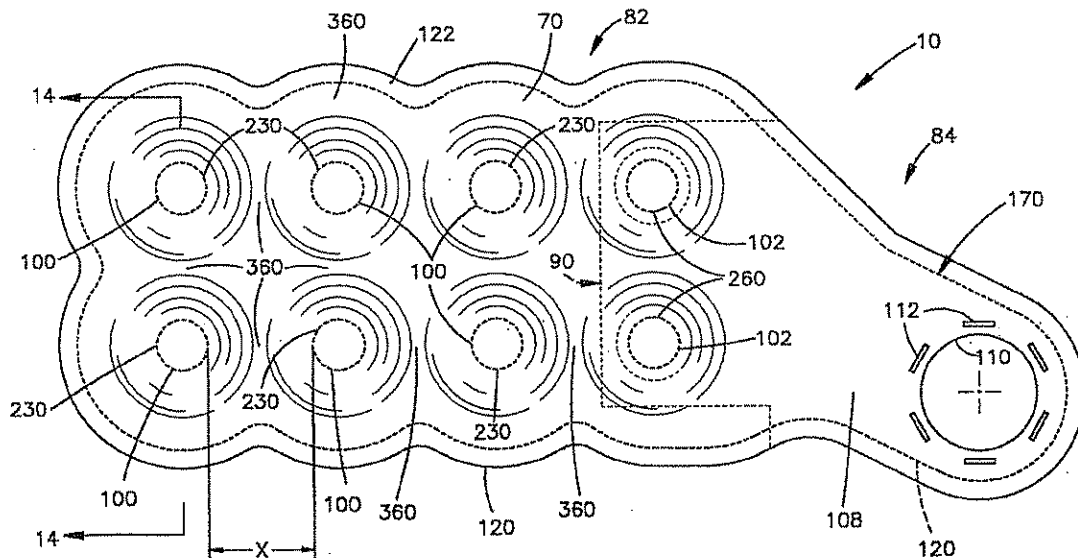
Society of Automotive Engineers, Vehicle Highway Report, SAE J1538 APR8, Glossary of Automotive Inflatable Restraint Terms.

Primary Examiner—Karin L. Tyson
Attorney, Agent, or Firm—Tarolli, Sundheim, Covell, Tum-
mino & Szabo

[57] ABSTRACT

A side impact head air bag (10) includes a plurality of spaced apart restraints (100, 102) for controlling the thickness of the air bag when inflated. In each restraint (100, 102), a circular stitching section (230, 260) joins an inner panel (70) and an outer panel (80) of the air bag (10). The stitching section (230, 260) defines a circular restraint section (200, 202) in each panel (70, 80). The stitching section (230, 260) blocks inflation fluid from flowing between the restraint sections (200, 202) of the restraints (100, 102). The tethers (100, 102) do not extend upon inflation of the air bag (10).

20 Claims, 6 Drawing Sheets

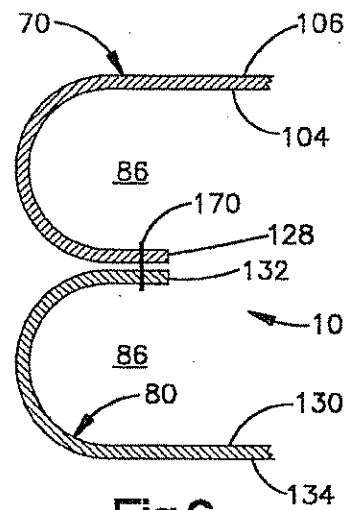
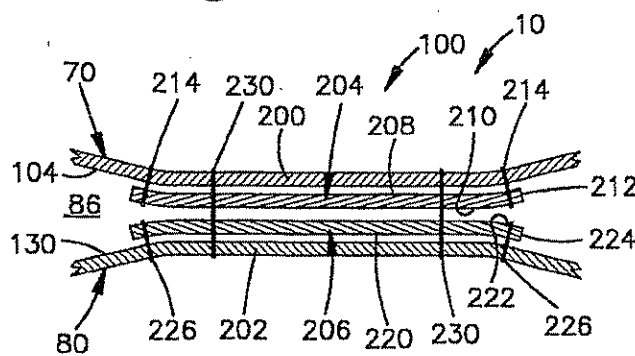
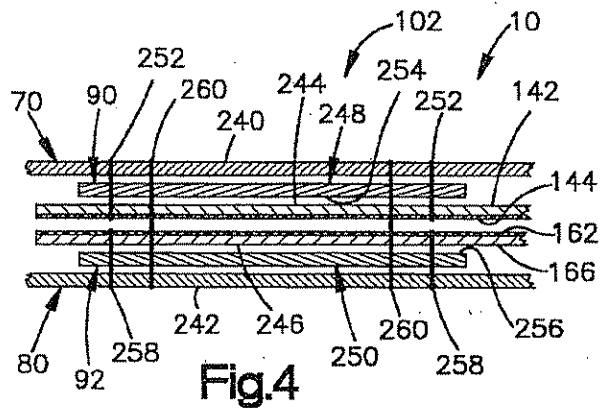
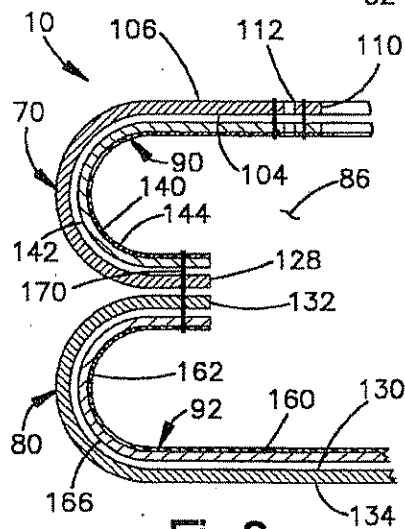
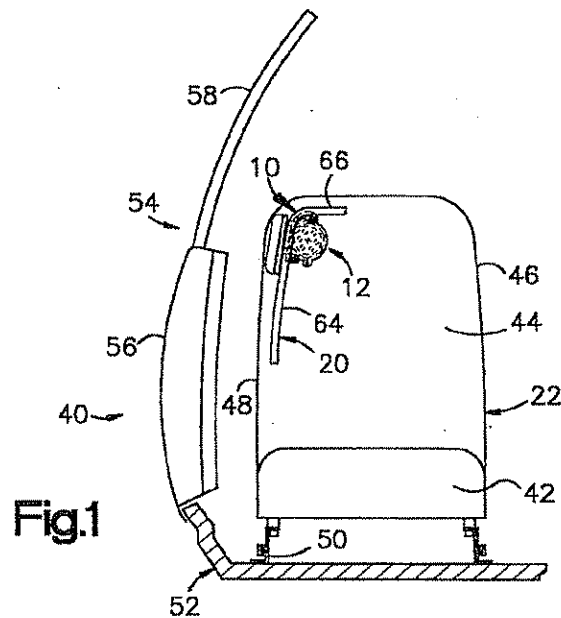


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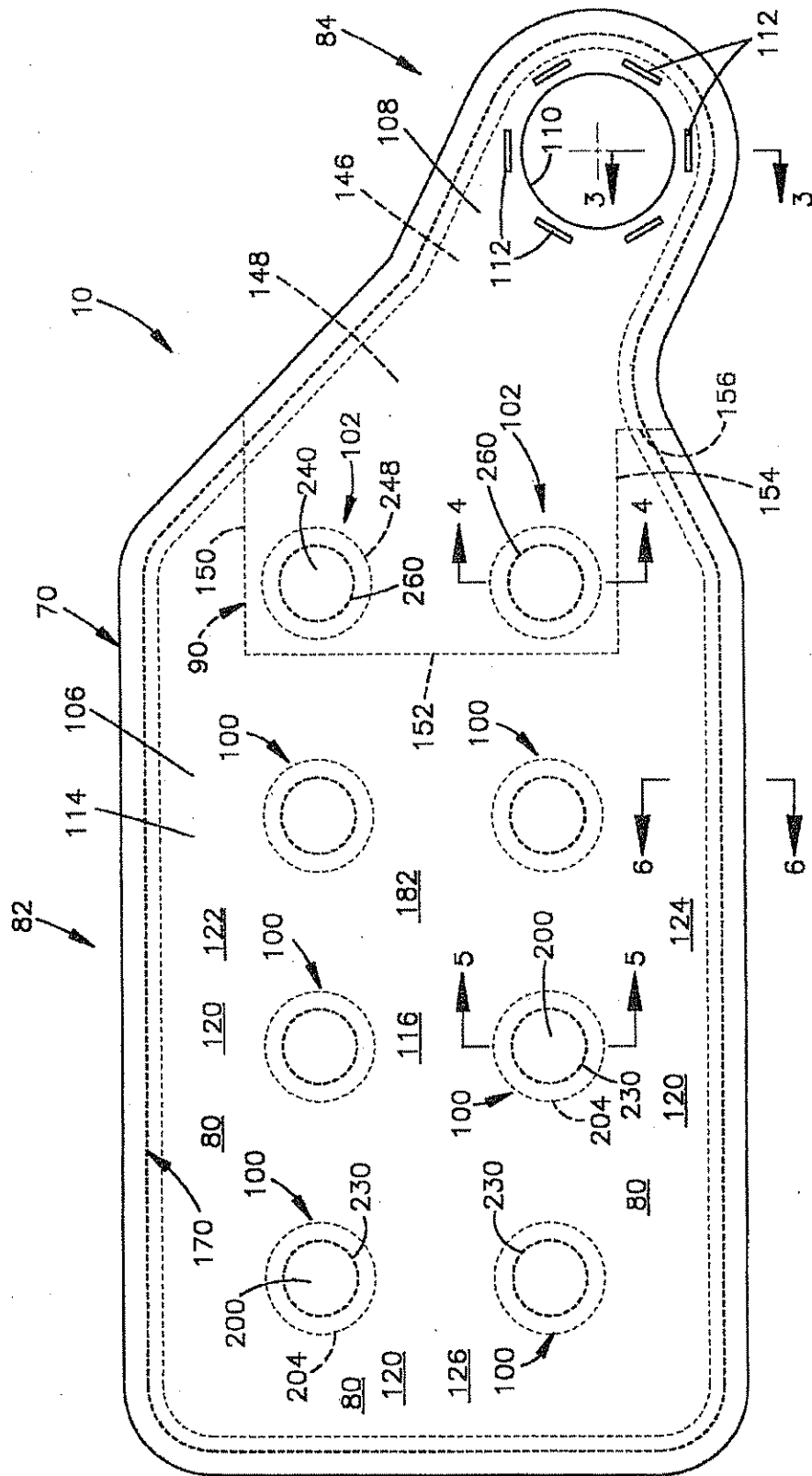


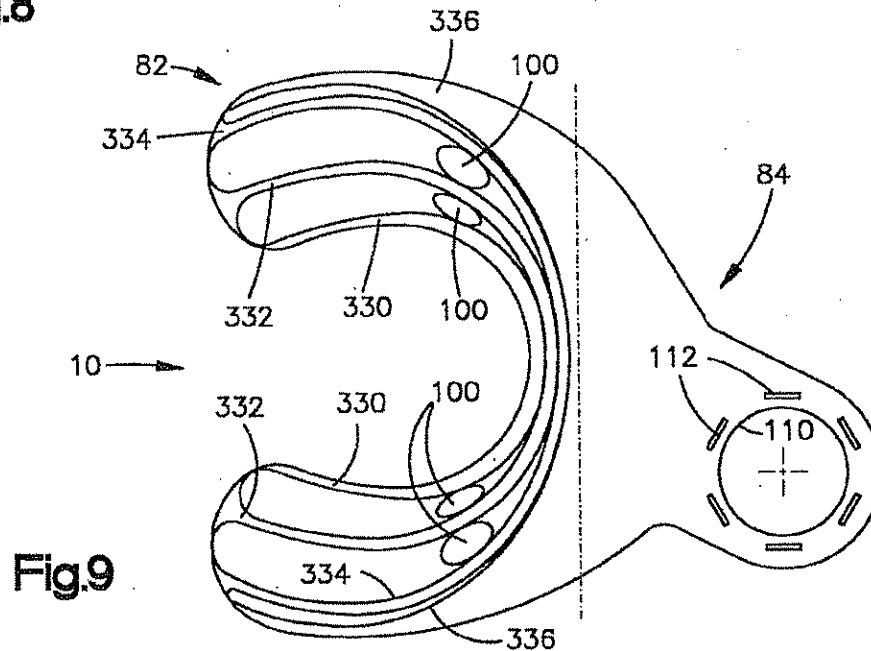
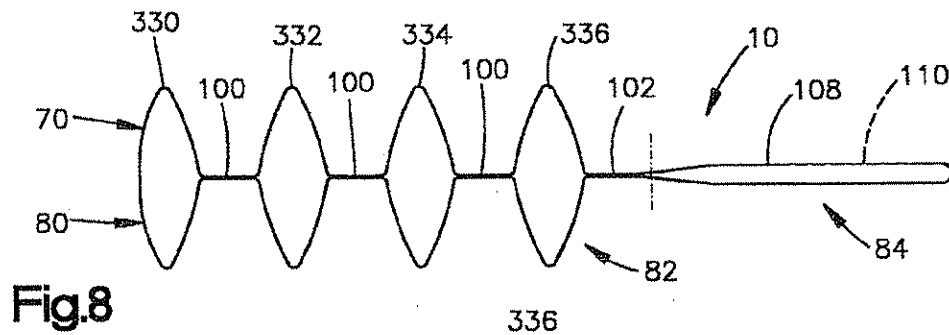
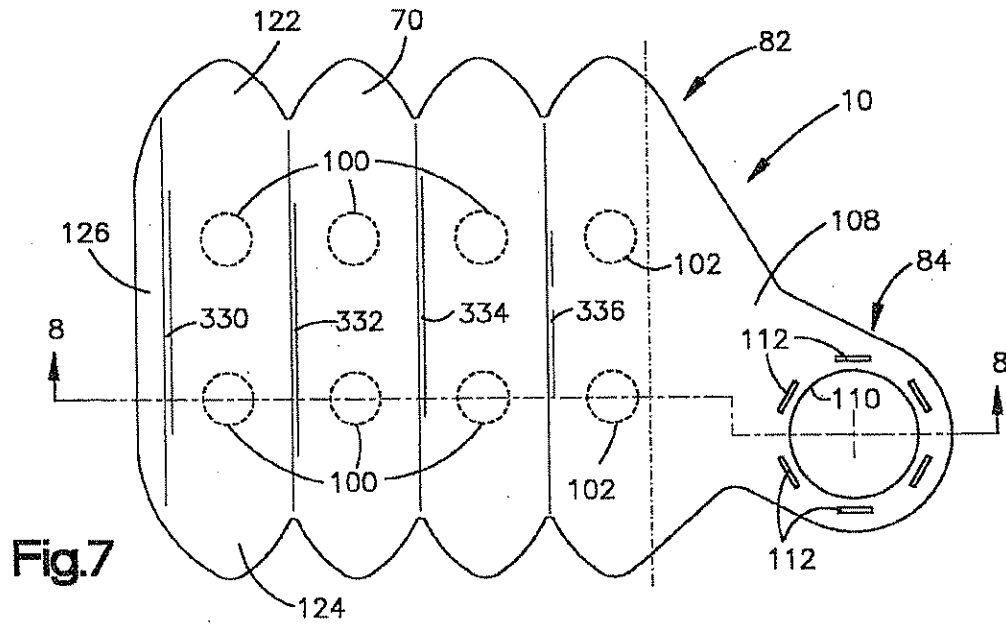
Fig. 2

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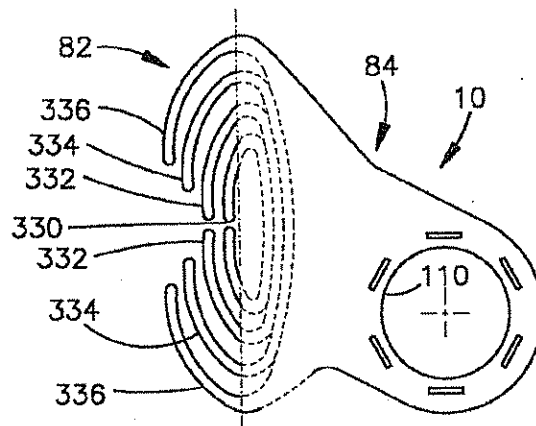


Fig.10

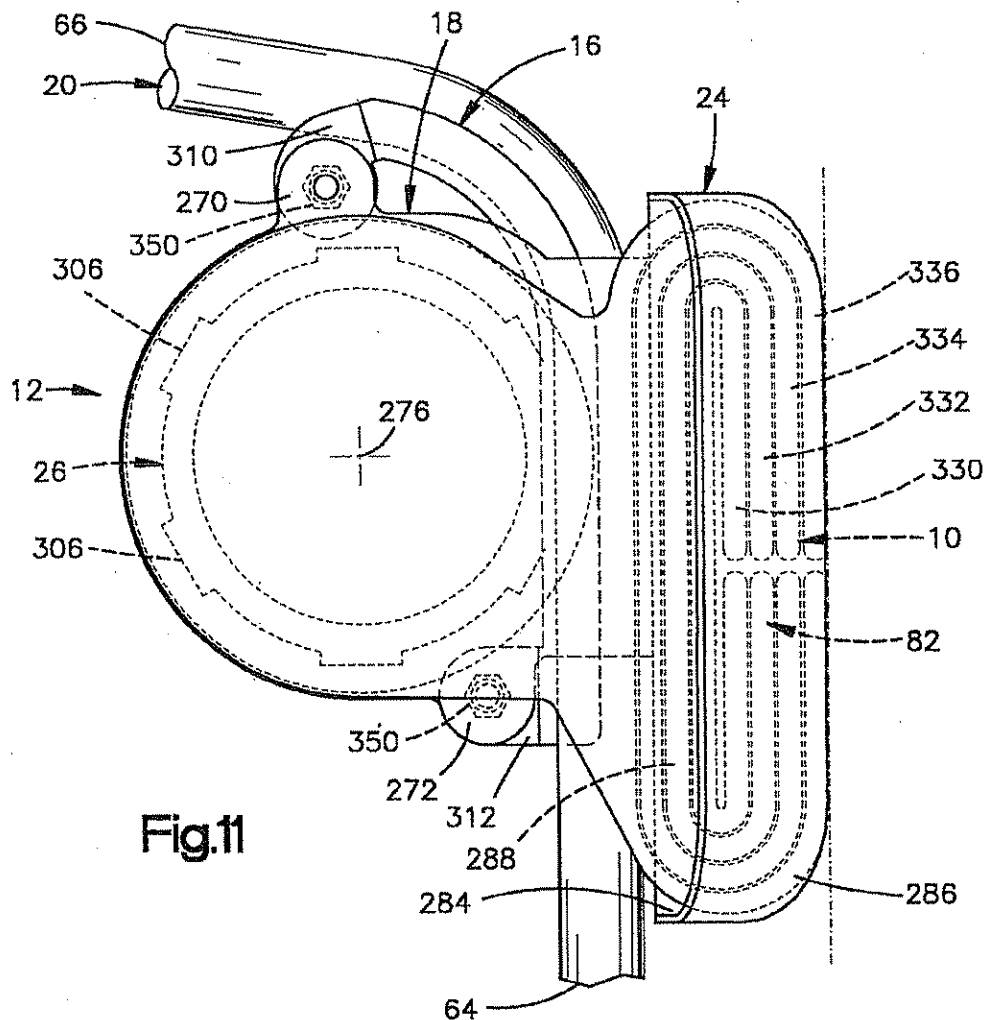


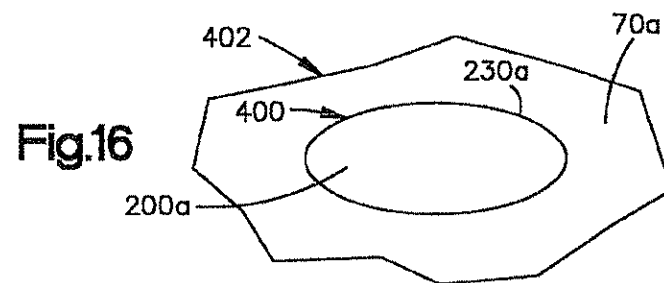
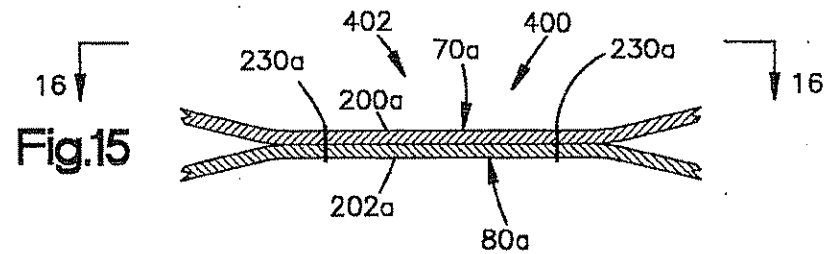
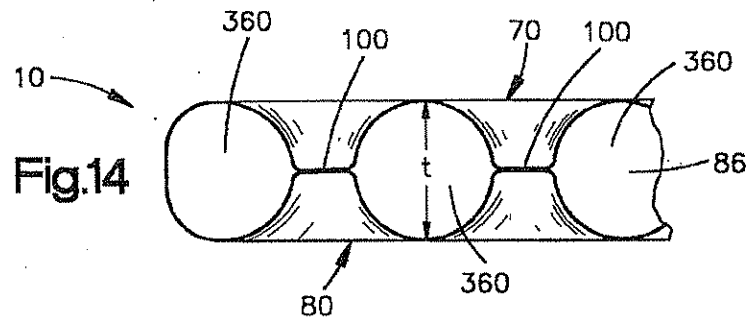
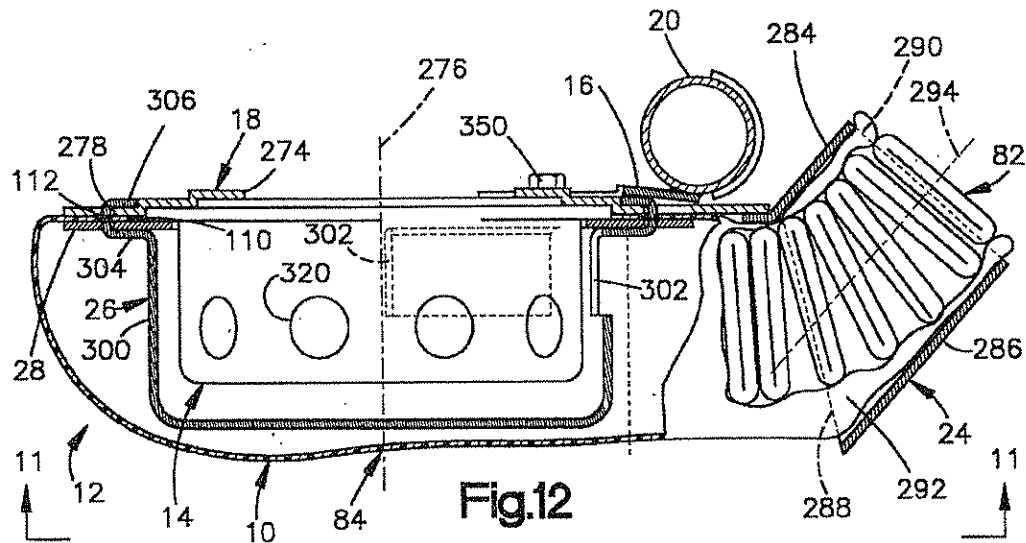
Fig.11

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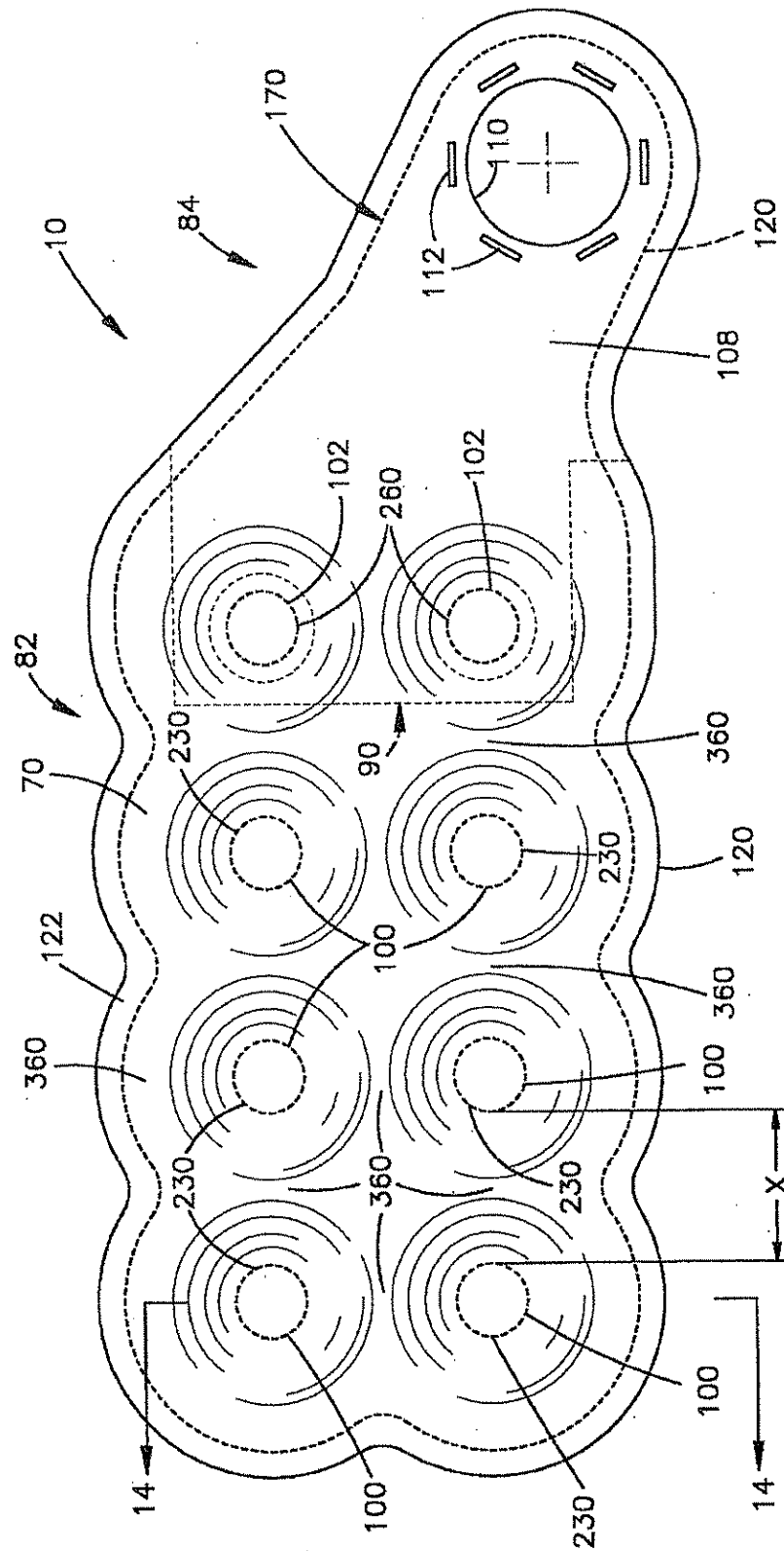


Fig.13

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AIR BAG INCLUDING RESTRAINT**BACKGROUND OF THE INVENTION****Technical Field**

The present invention relates to a vehicle occupant safety apparatus. In particular, the present invention relates to an inflatable vehicle occupant restraint, such as an air bag, which includes one or more tethers for controlling the shape of the air bag when inflated.

Description of the Prior Art

An inflatable vehicle occupant restraint such as an air bag is used to restrain or protect a vehicle occupant in the event of a vehicle collision requiring such restraint or protection. A typical air bag includes fabric panels which define an inflation fluid volume. When inflation fluid under pressure is supplied to the air bag, the panels move apart from each other as the air bag assumes an inflated condition.

It is known to use tethers extending between the panels of an air bag to control the shape and size of the inflated air bag. The tethers are commonly straps of fabric material disposed inside the air bag and having opposite ends stitched to the air bag panels. When the air bag becomes fully inflated, the tethers are fully extended and stop further movement of the panels away from each other.

An air bag for use in protecting a vehicle occupant in the event of a side impact to the vehicle inflates in the relatively narrow space between the occupant and the vehicle side structure. Multiple tethers are needed to maintain a narrow inflated dimension over the extent of an inflated side impact air bag. It can be relatively difficult and expensive to manufacture an air bag having multiple tethers which are formed as straps of fabric material extending between the panels of the air bag.

SUMMARY OF THE INVENTION

The present invention is an inflatable vehicle occupant restraint such as an air bag for, when inflated, protecting a vehicle occupant. The inflatable restraint has an uninflated condition and an inflated condition. The inflatable restraint comprises a first panel and a second panel each having a central portion, an outer peripheral portion, an inner side surface and an outer side surface. The outer peripheral portions of the first and second panels are sewn together along an outer stitching line to join the first and second panels to form a body portion of the inflatable restraint. When the inflatable restraint is in the inflated condition, the central portions of the first and second panels are at least partially spaced apart from each other and define an inflation fluid volume. A plurality of stitching sections join the central portion of the first panel to the central portion of the second panel at a plurality of spaced apart locations. Each one of the plurality of stitching sections is spaced apart from the other ones of the plurality of stitching sections. Each one of the stitching sections encloses a respective first restraint section of the central portion of the first panel and a respective second restraint section of the central portion of the second panel. Each one of the first restraint sections overlies a corresponding one of the second restraint sections when the inflatable restraint is in the inflated condition. The stitching sections block flow of inflation fluid from the inflation fluid volume between the first restraint sections of the first panel and the second tether sections of the second panel.

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BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the following description of the invention with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic front elevational view showing a vehicle safety apparatus including an inflatable vehicle occupant restraint in accordance with the present invention mounted in a vehicle seat;

FIG. 2 is an elevational view of the inflatable vehicle occupant restraint of FIG. 1 in an unfolded condition;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 2;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 2;

FIG. 7 is an elevational view of the inflatable vehicle occupant restraint of FIG. 1 showing a first step in a process of folding the inflatable restraint;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is an elevational view of the inflatable vehicle occupant restraint of FIG. 1 showing a further step in the process of folding the inflatable restraint;

FIG. 10 is an elevational view of the inflatable vehicle occupant restraint of FIG. 1 showing a still further step in the process of folding the inflatable restraint;

FIG. 11 is a rear elevational view of the vehicle safety apparatus of FIG. 1;

FIG. 12 is a sectional view of the vehicle safety apparatus of FIG. 1;

FIG. 13 is a view similar to FIG. 2 showing the inflatable restraint in an inflated condition;

FIG. 14 is a sectional view taken along line 14—14 of FIG. 13;

FIG. 15 is a view similar to FIG. 5 of a portion of an inflatable restraint in accordance with a second embodiment of the present invention; and

FIG. 16 is a view taken along line 16—16 of FIG. 15.

DESCRIPTION OF PREFERRED EMBODIMENT

The present invention relates to a vehicle occupant safety apparatus and, in particular, to an inflatable vehicle occupant restraint such as an air bag. The present invention is applicable to various inflatable restraint constructions. As representative of the present invention, FIG. 1 illustrates an inflatable vehicle occupant restraint or air bag 10.

The air bag 10 is part of an air bag module 12 (FIG. 1). The air bag module 12, described below in more detail with reference to FIGS. 11 and 12, includes an inflator 14 for inflating the air bag 10. A mounting bracket 16 and a base plate 18 secure the air bag 10 and the inflator 14 to a seat frame member 20 of a vehicle seat 22. The air bag module 12 also includes a chute 24 for guiding inflation of the air bag 10, a diffuser 26, and a clamp member or washer 28.

The vehicle seat 22 (FIG. 1) is illustrated as a front passenger seat of a vehicle 40 and includes a seat bottom portion 42 and a seat back 44. The seat back 44 has an

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inboard side 46 and an outboard side 48. The seat 22 may also include a headrest (not shown) which is supported on or is formed as a portion of the vehicle seat back 44.

The seat 22 is supported by tracks 50 on a body portion 52 of the vehicle 40. The vehicle body 52 also includes a side structure indicated generally at 54. In the illustrated configuration, the vehicle side structure 54 includes a door 56 and a window 58 which are disposed adjacent to the vehicle seat 22. It should be understood that the present invention is applicable to vehicles including other types of side structure, such as a van with no window or door disposed adjacent to the seat 22.

The seat frame member 20 is disposed in the seat back 44 of the vehicle seat 22. The seat frame member 20 has a tubular cross-section and is generally L-shaped in configuration. The L-shaped configuration of the seat frame member 20 is provided by a first leg 64 which extends generally vertically in the seat back 44 and a second leg 66 which extends generally horizontally in the seat back 44.

The air bag 10 is illustrated in FIGS. 2-6 in an uninflated condition (in FIGS. 3-6 the various layers of fabric material in the air bag are shown spaced apart for clarity). The air bag 10 includes an inner panel 70 (FIG. 2) and an outer panel 80, each made of fabric material, which are sewn together to define a body portion 82 and a neck portion 84 of the air bag. The panels 70 and 80 define between them an inflation fluid volume 86 for receiving inflation fluid from the inflator (FIG. 6). The air bag 10 also includes an inner partial panel 90 and an outer partial panel 92 (FIG. 3) which are coated and which extend over the neck portion 84 of the air bag and over only a small part of the body portion 82 of the air bag, as shown in dashed lines in FIG. 2. The air bag 10 further includes a plurality of restraints 100 and 102 for controlling movement of the inner and outer panels 70 and 80 away from each other.

The inner panel 70 (FIG. 2) is a single piece of fabric material, preferably uncoated woven nylon, which has an inner side surface 104 (FIG. 6) and an opposite outer side surface 106. An outer peripheral edge 128 of the inner panel 70 extends between the inner and outer side surfaces 104 and 106. The inner panel 70 includes a narrow neck portion 108 (FIG. 2) in which is formed an inflator opening 110. Six fastener openings 112 in the form of rectangular slots are disposed in a circular array around the inflator opening 110, for securing the air bag 10 in the module 12 in a manner described below.

The neck portion 108 of the inner panel 70 merges into a generally rectangular body portion 114 of the inner panel. The body portion 114 includes a central portion 116 with which the eight restraints 100, 102 are connected. A C-shaped outer peripheral portion 120 of the body portion 114 surrounds the central portion 116. The C-shaped outer peripheral portion 120 includes an upper side section 122 which is disposed above the restraints 100 and 102 as viewed in FIG. 2, a lower side section 124 disposed below the tethers as viewed in FIG. 2, and an outer end section 126 disposed at the left or outer end of the air bag 10 as viewed in FIG. 2.

The outer panel 80 (not seen in FIG. 2, but seen in part in FIGS. 3-6) does not include an inflator opening or fastener openings but is otherwise identical to the inner panel 70. The outer panel 80 may include one or more known vents (not shown) for venting inflation fluid from the inflation fluid volume 86 in a known manner. The outer panel 80 has an inner side surface 130 (FIG. 6) which is presented toward the inner side surface 104 of the inner panel. An outer

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peripheral edge 132 of the outer panel 80 extends between the inner side surface 130 and an opposite outer side surface 134 of the outer panel.

The inner partial panel 90 (FIG. 2) is made from a single piece of fabric material having an inner side surface 140 (FIG. 3) and an outer side surface 142. The inner partial panel 90 is preferably made from woven nylon. A coating or layer 144 of fluid impermeable material such as neoprene is disposed on the inner side surface 140 of the inner partial panel 90.

A neck portion 146 (FIG. 2) of the inner partial panel 90 is co-extensive with the neck portion 108 of the inner panel 70. The neck portion 146 of the inner partial panel 90 has an inflator opening and fastener openings which are co-extensive with those on the inner panel 70. A body portion 148 of the inner partial panel 90 extends over only a part of the body portion 82 of the inner panel 70. The body portion 148 of the inner partial panel 90 is defined generally by a series of straight edges 150, 152, 154 and 156.

The outer partial panel 92 (FIG. 3) underlies and is substantially identical to the inner partial panel 90 but does not include an inflator opening or fastener openings. The outer partial panel 92 has an inner side surface 160 and an outer side surface 166. The inner side surface 160 of the outer partial panel 92 is presented toward the inner side surface 140 of the inner partial panel 90. A coating 162 of fluid impermeable material such as neoprene is disposed on the inner side surface 160 of the outer partial panel 92.

An outer stitching line 170 (FIGS. 2 and 3) joins the inner panel 70, the outer panel 80, the inner partial panel 90, and the outer partial panel 92. The outer stitching line 170 includes a series of stitches which extend completely around the outer periphery of the air bag 10. Because the outer stitching line 170 is sewn when the panels are inverted or "inside out" from the condition shown in the drawings, the outer peripheral edges 128 and 132 of the panels 70 and 80, respectively, lie between the inner side surfaces 104 and 130 of the panels when they are turned "right side out" after sewing.

The body portion 82 (FIG. 2) of the air bag 10 includes the body portion 114 of the inner panel 70 as well as the body portion of the outer panel 80. The body portion 82 of the air bag 10 has an outer peripheral portion 180 which includes the C-shaped outer peripheral portion 120 of the inner panel 70 and the C-shaped outer peripheral portion of the outer panel 80. The body portion 82 of the air bag 10 further includes a central portion 182 which includes the central portion 116 of the inner panel 70 and the central portion of the outer panel 80, as well as the leftmost (as viewed in FIG. 2) parts of the inner and outer partial panels 90 and 92. The neck portion 84 of the air bag 10 includes the neck portion 108 of the inner panel 70 and the neck portion of the outer panel 80, as well as the neck portions of the inner and outer partial panels 90 and 92.

The restraints 100 and 102 are enclosed within the outer stitching line 170 and are disposed in the central portion 182 of the body portion 82 of the air bag 10. The restraints 100 and 102 interconnect the inner panel 70 and the outer panel 80 to control movement of the panels 70 and 80 away from each other. In the illustrated air bag 10, the six restraints 100, which are identical to each other, join the inner and outer panels 70 and 80 but do not join the inner and outer partial panels 90 and 92. The two restraints 102, which are identical to each other, join the inner and outer partial panels 90 and 92 as well as the inner and outer panels 70 and 80.

An exemplary restraint 100, as best seen in FIGS. 2 and 5, includes a circular restraint section 200 of the inner panel

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70, a circular restraint section 202 of the outer panel 80, two fabric reinforcing pads 204 and 206, and several stitching sections joining the various fabric portions.

The inner reinforcing pad 204 (FIGS. 2 and 5) is circular in configuration and includes opposite first and second side surfaces 208 and 210 (FIG. 5) and a circular outer peripheral edge 212. The inner reinforcing pad 204 is disposed between the inner and outer panels 70 and 80, at a location adjacent to the inner panel 70. The first side surface 208 of the inner reinforcing pad 204 overlies and is in abutting engagement with the inner side surface 104 of the inner panel 70. A circular stitching section 214 at the outer periphery of the inner reinforcing pad 204 joins the inner reinforcing pad to the inner panel 70.

The outer reinforcing pad 206 is identical to the inner reinforcing pad 204. Thus, the outer reinforcing pad 206 is circular in configuration and has opposite first and second side surfaces 220 and 222 and a circular outer peripheral edge 224. The outer reinforcing pad 206 is disposed between the inner and outer panels 70 and 80 at a location adjacent to the outer panel 80. The first side surface 220 of the outer reinforcing pad 206 overlies and is in abutting engagement with the inner side surface 130 of the outer panel 80. The outer reinforcing pad 206 is sewn at its outer periphery to the outer panel 80 with a circular stitching section 226.

The reinforcing pads 204 and 206 are sewn to the inner and outer panels 70 and 80, respectively, when the panels 70 and 80 are inverted or "inside out" from the condition shown in the drawings. After the inner panel 70 and the outer panel 80 are sewn with the outer stitching line 170, the inner and outer panels are inverted or turned "right side out" into the condition shown in the drawings. The inner and outer panels 70 and 80, together with the inner and outer reinforcing pads 204 and 206, are then sewn to each other with a circular stitching section 230 to form the restraint 100.

The stitching section 230 includes a series of stitches arranged in a circular pattern which extend through the inner panel 70, the inner reinforcing pad 204, the outer reinforcing pad 206, and the outer panel 80. The stitching section 230 encloses and defines the circular restraint section 200 of the inner panel 70. The stitching section 230 similarly encloses and defines the circular restraint section 202 of the outer panel 80.

The circular restraint section 200 of the inner panel 70 overlies the circular restraint section 202 of the outer panel 80. The second side surface 210 of the inner reinforcing pad 204 overlies and is in abutting engagement with the second side surface 222 of the outer reinforcing pad 206. The circular stitching section 230 blocks flow of inflation fluid from the inflation fluid volume 86 to a location between the restraint section 200 of the inner panel 70 and the restraints section 202 of the outer panel 80.

Each one of the six restraints 100 includes an identical circular stitching section 230. Each restraint 100 is spaced apart from the other restraints 100. Thus, each one of the stitching sections 230 is spaced apart from the other stitching sections 230.

Each restraint 102 (FIGS. 2 and 4) includes a circular restraint section 240 of the inner panel 70 and a circular restraint section 242 of the outer panel 80. Each restraints 102 also includes a circular restraint section 244 of the inner partial panel 90, a circular restraint section 246 of the outer partial panel 92, and two fabric reinforcing pads 248 and 250. A plurality of stitching sections join together these various fabric portions.

The inner reinforcing pad 248 (FIG. 4) is identical to the reinforcing pads 204 and 206 illustrated in FIG. 5. A first

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side surface 254 of the inner reinforcing pad 248 overlies and is in abutting engagement with the uncoated outer side surface 142 of the inner partial panel 90. The inner reinforcing pad 248 is sewn between the inner panel 70 and the inner partial panel 90 with a circular stitching section 252 extending around the outer periphery of the pad 248.

The outer reinforcing pad 250 is identical to the inner reinforcing pad 248. A first side surface 256 of the outer reinforcing pad 250 overlies and is in abutting engagement with the uncoated outer side surface 166 of the outer partial panel 92. The outer reinforcing pad 250 is sewn between the outer panel 80 and the outer partial panel 92 with a circular stitching section 258 which extends around the outer periphery of the pad 250.

A circular stitching section 260 joins the inner and outer panels 70 and 80, the inner and outer partial panels 90 and 92, and the reinforcing pads 248 and 250. The stitching section 260 encloses and defines the circular restraint section 240 of the inner panel 70, and encloses and defines the circular restraint section 242 of the outer panel 80. The stitching section 260 blocks flow of inflation fluid from the inflation fluid volume 86 to a location between the restraint section 240 of the inner panel 70 and the restraint section 242 of the outer panel 80.

The restraint section 240 of the inner panel 70 overlies the restraint section 242 of the outer panel 80. The coating 144 on the inner side surface 140 of the inner partial panel 90 overlies and is in abutting engagement with the coating 162 on the inner side surface 160 of the outer partial panel 92.

After the air bag 10 is completely sewn and assembled, the air bag is assembled with the other parts of the air bag module 12 as seen in FIGS. 11 and 124 (In FIG. 12, the air bag 10 is shown, for clarity, as being made from only one layer of uncoated fabric material.)

The base plate 18 (FIGS. 11 and 12) of the air bag module 12 is a generally planar sheet metal stamping. The base plate 18 includes two radially projecting mounting ears 270 and 272 (FIG. 11), each having a respective fastener opening. An annular axially extending inner edge surface 274 (FIG. 12) of the base plate 18 defines a circular central opening in the base plate 18. The central opening is centered on an axis 276. Six identical mounting slots 278 in the base plate 18 are equally spaced in a circular array centered on the axis 276. The slots 278 have the same configuration as the fastener openings 112 in the neck portion 108 of the inner panel 70 of the air bag 10.

The chute 24 is welded to the base plate 18 but could alternatively be formed as one piece with the base plate 18. The chute 24 has a wide, flat tubular configuration and includes an inner side wall 284 and an outer side wall 286. The walls of the chute 24 define an inlet opening 288 and an outlet opening 290 of the chute. A chamber or passage 292, enclosed within and defined by the walls of the chute 24, extends between the inlet opening 288 and the outlet opening 290 of the chute 24. The chute 24 has a central axis 294 which extends parallel to the chute walls 284 and 286. The chute axis 294 extends between the inlet opening 288 and the outlet opening 290 at an angle to the plane of the base plate 18.

The diffuser 26 is a one-piece generally cup-shaped member and includes a cylindrical axially extending side wall 300 which is centered on the axis 276 of the module 12. A plurality of spaced apart fluid flow openings 302 (FIG. 12) are formed in the side wall of the diffuser 26 between the inflator 14 and the chute 24. An annular mounting flange 304 of the diffuser 26 extends radially outward from the diffuser

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side wall 300. Six identical mounting tabs 306 project axially from the mounting flange 304 of the diffuser 26. The mounting tabs 306 are equally spaced in a circular array centered on the axis 276. Each mounting tab 306 has a rectangular configuration sized to fit through the mounting slots 278 in the base plate 18 and through the fastener openings 112 in the air bag 10.

The washer 28 (FIG. 12) is a flat, annular piece of metal having parallel radially extending inner and outer side surfaces. Six identical mounting slots (unnumbered) in the washer 28 are equally spaced in a circular array centered on the axis 276 for receiving the mounting tabs 306 on the diffuser 26. Each mounting slot in the washer 28 has the same rectangular configuration as the mounting slots 278 in the base plate 18.

The mounting bracket 16 is a single piece of sheet metal stamped and formed to a generally J-shaped configuration as best seen in FIG. 11. The mounting bracket 16 is generally planar and includes a first end portion 310 and a second end portion 312, each having a fastener opening.

The inflator 14 is a known pyrotechnic air bag inflator having a plurality of gas outlet openings 320. A radially extending mounting flange of the inflator 14 has parallel inner and outer side surfaces. Lead wires (not shown) extend from the inflator 14. The lead wires are connected to electric circuitry (not shown) of the vehicle including a collision sensor and a power source such as the vehicle battery.

The air bag module 12 is assembled by first moving the diffuser 26 and the washer 28 through the inflator opening 110 in the neck portion 108 of the inner panel 70 of the air bag 10 to a position inside the air bag. The diffuser 26 is engaged with the washer 28 so that the mounting tabs 306 on the diffuser extend through the mounting slots (unnumbered) in the washer. The diffuser 26 and the washer 28 are positioned within the air bag 10 so that the mounting tabs 306 on the diffuser also extend through the fastener openings 112 in the neck portion 84 of the air bag. The washer 28 is thus disposed between the mounting flange 304 of the diffuser 26 and the air bag 10. The mounting tabs 306 on the diffuser 26 extend only axially and are not yet bent radially inward as shown in FIGS. 11 and 12.

The inflator 14 is inserted axially into the air bag 10 through the inflator opening 110 to a position within the side wall 300 of the diffuser 26. The mounting flange on the inflator 14 engages a portion of the washer 28. The base plate 18 is next positioned against the air bag 10 and the inflator 14 so that the mounting tabs 306 on the diffuser 26 extend through the mounting slots 278 in the base plate. The projecting end portions of the mounting tabs 306 on the diffuser 26 are thereafter bent radially inward so as to overlie the base plate 18, as seen in FIG. 12. The mounting tabs 306 on the diffuser 26 clamp together the base plate 18, the air bag 10, the washer 28, the inflator 14 and the diffuser 26.

The air bag 10 is folded and stored in the chamber 292 in the chute 24 in the manner shown schematically in FIGS. 7-10. A series of pleats 330, 332, 334, and 336 are formed in the body portion 82 of the air bag 10. The pleats 330-336 are formed by moving the material of the inner panel 70 apart from the material of the outer panel 80 as best seen in FIG. 8. The pleats 330-336 are formed between the restraints 100, 102 and extend from the upper side portion 122 of the air bag 10 to the lower side portion 124 of the air bag.

The body portion 82 of the air bag 10 is thereafter pushed or tucked inside the neck portion 84 of the air bag as shown in FIGS. 9 and 10, in a direction to the right as viewed in

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FIG. 9. Specifically, the fabric material which forms the neck portion 108 of the inner panel 70 of the air bag 10 is moved apart from the fabric material which forms the neck portion of the outer panel 80 of the air bag, to form a pouch or sack into which the body portion 82 of the air bag is moved. The body portion 82 of the air bag 10 is folded along the pleats 330-336 so that the upper and lower (as viewed in FIGS. 9 and 10) side portions of the air bag wrap around and enclose the outer end portion.

When the air bag 10 is folded in this manner, substantially all of the folded body portion 82 of the air bag is stored in the chute 24 as best seen in FIGS. 11 and 12. Some of the folded body portion 82 of the air bag 10 may be located between the chute 24 and the diffuser 26. Preferably only a minimal amount, or even none, of the folded body portion 82 of the air bag 10 projects beyond the outlet opening 290 of the chute 24. The neck portion 84 of the air bag 10 extends around and wraps around the inflator 14 and the diffuser 26 as best seen in FIG. 12. The neck portion 84 of the air bag 10 is connected with the base plate 18 at a location spaced from and outside of the chute 24.

To secure the assembled air bag module 12 in the vehicle seat back 44, the mounting bracket 16 is first welded to the seat frame member 20. The base plate 18 of the assembled air bag module 12 is thereafter secured to the mounting bracket 16 with fasteners 350 (FIG. 12) through the mounting portions 310 and 312 of the mounting bracket and through the fastener openings in the mounting ears 270 and 272 of the base plate. As a result, the base plate 18, the inflator 14, the air bag 10, the chute 24, the diffuser 26, and the washer 28 are securely fastened to the seat frame member 20.

The air bag module 12, when mounted to the seat frame member 20, is disposed within a cavity in the foam material (not shown) of the vehicle seat back 44. The cavity is large enough so as not to prevent the flow of inflation fluid from the inflator 14 through the neck portion 84 of the air bag 10 into the body portion 82 of the air bag. The chute 24, along with the body portion 82 of the air bag 10, is covered from the outside of the seat back 44 by the foam material and by the fabric material outer covering of the seat back. The foam material and the fabric material covering are selected and installed so as not to prevent inflation of the air bag 10 into the space between the vehicle seat 22 and the vehicle side structure 54.

In the event of a side impact to the vehicle 40 of a magnitude sufficient to require protection of the vehicle occupant, the vehicle electric circuitry including the collision sensor sends an electric current to the inflator 14. The inflator 14 is actuated in a known manner and directs inflation fluid under pressure into the diffuser 26. The walls of the diffuser 26 direct the inflation fluid through the fluid flow openings 302 in the diffuser and into the neck portion 84 of the air bag 10. The neoprene layers 144 and 162 on the inner and outer partial panels 90 and 92 of the air bag 10 prevent inflation fluid from leaking out of the neck portion 84 of the air bag.

The neck portion 84 of the air bag 10 directs the inflation fluid from the diffuser 26 into the body portion 82 of the air bag. The body portion 82 of the air bag 10 inflates from the folded, stored condition shown in FIGS. 11 and 12 to an inflated condition as shown schematically in FIG. 13, adjacent to the vehicle side structure 54, to protect the vehicle occupant. The chute 24 guides the air bag 10 to inflate in the direction of the chute axis 294. The body portion 82 of the air bag 10 inflates forward and outward relative to the

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vehicle seat back 44 between the head of an occupant of the vehicle seat 22 and the side structure 40 of the vehicle 40.

The pressure of the inflation fluid in the inflation fluid volume 86 in the air bag 10 causes the inner panel 70 and the outer panel 80 to move away from each other as the air bag assumes an inflated condition. As this relative movement of the panels 70 and 80 occurs, the restraints 100 and 102 resist movement of the inner panel and the outer panel away from each other. Because of the fluid pressure in the air bag 10 between the panels 70 and 80, a tensile load is placed on the restraints 100 and 102 in a direction extending between the inner panel 70 and the outer panel 80. The restraints 100 and 102 do not extend, and thus the restraints limit and define the thickness or inflated dimension of the air bag 10 as measured between the inner panel 70 and the outer panel 80.

The restraints 100 and 102 are arranged spaced apart in a grid-like pattern over the body portion 82 of the air bag 10, as best seen in FIGS. 2 and 13. The thickness of the air bag 10, when inflated, at the location of the restraints 100 and 102, is effectively zero. That is, there is no inflation fluid between the tether sections of the inner panel 70 and the tether sections of the outer panel 80 at these locations of the restraints 100 and 102. Also, the thickness of the air bag 10 at the outer stitching line 170, when inflated, is effectively zero because the inner panel 70 and the outer panel 80 are sewn together in abutting engagement at the outer stitching line.

At other locations on the body portion 82, the air bag 10, when inflated, has a measurable and substantial thickness. That is, at these other locations, the inner panel 70 and the outer panel 80 are held apart from each other by the inflation fluid and define between them an interconnected series of sections 360 of the single inflation fluid volume 86, as best seen in FIG. 14. In these inflation fluid sections 360, the body portion 82 of the air bag 10 attempts to assume a spherical shape as the inflation fluid forces apart the inner panel 70 and the outer panel 80.

The spacing between adjacent restraints 100 and/or 102 is selected and determined in accordance with the equation:

$$X = \frac{(\pi t)^2}{2} \quad (1)$$

where "X" (FIG. 13) is the distance between a pair of adjacent stitching sections 230 and/or 260, and "t" (FIG. 14) is the thickness when inflated of the air bag section 360 disposed between those stitching sections 230 and/or 260. The spacing between each restraint 100 or 102 and the outer stitching line 170 is also determined in accordance with the same equation. In that case, "X" in Equation 1 represents the perpendicular distance between the outer stitching line 170 and the stitching section 230 and/or 260. The restraints 100 and 102 are arranged on the air bag 10 so that the overall thickness of the inflated portions of the air bag 10 is substantially uniform over the extent of the body portion 82.

The restraints 100 and 102 are advantageous in that they do not require the sewing of elongate fabric strips between the inner and outer panels 70 and 80. The only internal parts of the restraints 100 and 102, i.e., the reinforcing pads 204, 206, 248, and 250, are sewn to the panels 70 and 80 from the outside. This construction greatly simplifies the fabrication of the air bag 10, especially in view of the fact that multiple restraints are used.

FIGS. 15 and 16 illustrate a restraints 400 which is included in an air bag 402 constructed in accordance with a second embodiment of the present invention. The air bag 402 is generally similar to the air bag 10, and similar parts are given similar reference numerals. The air bag 402

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includes an inner panel 70a and an outer panel 80a. The restraint assembly 400 does not include any reinforcing pads between the inner panel 70a the outer panel 80a. Thus, a stitching section 230a joins the inner panel 70a in abutting engagement with the outer panel 80a. The stitching section 230a is elliptical rather than circular in configuration. The stitching section 230a encloses and defines an elliptical restraint section 200a of the inner panel 70a and an elliptical restraint section 202a of the outer panel 80a.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications in the invention. For example, the stitching sections in the restraints can have a configuration other than circular or elliptical. Also, the coated partial panels need not be incorporated in the air bag. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

Having described the invention, I claim:

1. An inflatable vehicle occupant restraint such as an air bag for, when inflated, protecting a vehicle occupant, said inflatable restraint having an uninflated condition and an inflated condition, said inflatable restraint comprising:

a first panel having a central portion and an outer peripheral portion;

a second panel having a central portion and an outer periphery portion;

said outer peripheral portions of said first and second panels being sewn together along an outer stitching line to join said first and second panels to form a body portion of said inflatable restraint;

said central portions of said first and second panels being at least partially spaced apart from each other when said inflatable restraint is in the inflated condition to define an inflation fluid volume between said central portions of said first and second panels; and

a plurality of non-extensible assemblies disposed within said outer stitching line and joining said central portion of said first panel to said central portion of said second panel at a plurality of spaced apart locations to control the width of said inflation fluid volume as measured between said first and second panels, each one of said assemblies comprising:

(a) a first section of said central portion of said first panel;

(b) a second section of said central portion of said second panel; and

a stitching section extending around and enclosing said first section and said second section, said stitching section joining said first section to said second section in an overlying relationship, said stitching section blocking flow of inflation fluid from said inflation fluid volume between said first section and said second section.

2. An inflatable restraint as set forth in claim 1 wherein said first section is in abutting engagement with said second section in each respective one of said assemblies.

3. An inflatable restraint as set forth in claim 1 wherein said stitching section comprises a series of stitches arranged in a circular pattern, each one of said first and second sections having a circular configuration.

4. An inflatable restraint as set forth in claim 1 wherein each one of said assemblies includes at least one reinforcing pad disposed intermediate said first section and second section, said reinforcing pad being in abutting engagement with one of said first and second sections.

5. An inflatable restraint as set forth in claim 4 wherein each one of said assemblies includes a first reinforcing pad

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sewn to and overlying said first section of said first panel and a second reinforcing pad sewn to and overlying said second section of said second panel, said first and second reinforcing pads being disposed intermediate said first and second sections, said first reinforcing pad overlying said second reinforcing pad, said stitching section joining said first and second reinforcing pads to said first and second sections.

6. An inflatable restraint as set forth in claim 4 wherein said stitching section comprises a series of stitches arranged in a circular pattern, each one of said first and second sections having a circular configuration.

7. An inflatable restraint as set forth in claim 1 wherein said inflatable restraint has a single continuous inflation fluid volume including a plurality of sections which are interconnected in fluid communication and between which said assemblies are disposed, said assemblies and said outer stitching section defining said plurality of inflation fluid volume sections.

8. An inflatable restraint as set forth in claim 7 wherein said sections of said inflation fluid volume which are disposed between adjacent assemblies, when inflated, have substantially the same thickness as said sections of said inflation fluid volume which are disposed between said assemblies and said outer stitching line.

9. An inflatable restraint as set forth in claim 1 wherein said assemblies are arranged spaced apart in a grid-like pattern over said body portion of said air bag, each pair of adjacent assemblies defining between them a section of said body portion of said air bag having a thickness when inflated, the distance between a pair of adjacent assemblies being determined in accordance with the equation:

$$X = \frac{(\pi)t}{2} \quad (1)$$

where X is the distance between said adjacent stitching sections, and t is the thickness when inflated of said section of said body portion of said air bag between said adjacent stitching sections.

10. An inflatable vehicle occupant restraint such as an air bag for, when inflated, protecting a vehicle occupant, said inflatable restraint having an uninflated condition and an inflated condition, said inflatable restraint comprising:

- a first panel having a central portion, an outer peripheral portion, an inner side surface and an outer side surface;
- a second panel having a central portion, an outer peripheral portion, an inner side surface and an outer side surface;

said outer peripheral portions of said first and second panels being sewn together along an outer stitching line to join said first and second panels to form a body portion of said inflatable restraint, said inner side surface of said first panel being presented toward said inner side surface of said second panel;

said central portions of said first and second panels being at least partially spaced apart from each other when said inflatable restraint is in the inflated condition to define an inflation fluid volume between said central portions of said first and second panels; and

a plurality of stitching sections joining said central portion of said first panel to said central portion of said second panel at a plurality of spaced apart locations, each one of said plurality of stitching sections being spaced apart from the other ones of said plurality of stitching sections;

each one of said stitching sections enclosing a respective first section of said central portion of said first panel

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and a respective second section of said central portion of said second panel;

each one of said first sections overlying a corresponding one of said second sections when said inflatable restraint is in the inflated condition;

said stitching sections blocking flow of inflation fluid from said inflation fluid volume between said first sections of said first panel and said second sections of said second panel.

11. An inflatable restraint as set forth in claim 10 wherein said first section of said first panel is spaced from said second section of said second panel by a first predetermined distance when said inflatable restraint is in the uninflated condition, said first section of said first panel also being spaced from said second section of said second panel by said first predetermined distance when said inflatable restraint is in the inflated condition.

12. An inflatable restraint as set forth in claim 11 wherein said first section of said first panel is in abutting engagement with said second section of said second panel so that said first predetermined distance is approximately zero.

13. An inflatable restraint as set forth in claim 11 wherein said first section of said first panel is separated from said second section of said second panel by at least one reinforcing pad so that said first predetermined distance is approximately equal to the thickness of said at least one reinforcing pad.

14. An inflatable restraint as set forth in claim 10 wherein each one of said assemblies includes a first reinforcing pad sewn to and overlying said first section of said first panel and a second reinforcing pad sewn to and overlying said second section of said second panel, said first and second reinforcing pads being disposed intermediate said first and second sections, said first reinforcing pad overlying said second reinforcing pad, said stitching section joining said first and second reinforcing pads to said first and second sections.

15. An inflatable restraint as set forth in claim 10 wherein said stitching section comprises a series of stitches arranged in a circular pattern, each one of said first and second sections having a circular configuration.

16. An inflatable restraint as set forth in claim 10 wherein said inflatable restraint has a single continuous inflation fluid volume including a plurality of sections which are interconnected in fluid communication and between which said assemblies are disposed, said assemblies and said outer stitching section defining said plurality of inflation fluid volume sections.

17. An inflatable restraint as set forth in claim 16 wherein said sections of said inflation fluid volume which are disposed between adjacent assemblies, when inflated, have substantially the same thickness as said sections of said inflation fluid volume which are disposed between said assemblies and said outer stitching line.

18. An inflatable restraint as set forth in claim 10 wherein said assemblies are arranged spaced apart in a grid-like pattern over a body portion of said air bag.

19. An inflatable vehicle occupant restraint such as an air bag for, when inflated, protecting a vehicle occupant, said inflatable restraint having an uninflated condition and an inflated condition, said inflatable restraint comprising:

- a first panel having a central portion and an outer peripheral portion;
- a second panel having a central portion and an outer peripheral portion;

said outer peripheral portions of said first and second panels being sewn together along an outer stitching line

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to join said first and second panels to form a body portion of said inflatable restraint;

said central portions of said first and second panels being at least partially spaced apart from each other when said inflatable restraint is in the inflated condition to define an inflation fluid volume between said central portions of said first and second panels;

a plurality of non-extensible assemblies disposed within said outer stitching line and joining said central portion of said first panel to said central portion of said second panel at a plurality of spaced apart locations to control the width of said inflation fluid volume as measured between said first and second panels, each one of said assemblies comprising:

(a) a first section of said central portion of said first panel;

(b) a second section of said central portion of said second panel;

a stitching section extending around and enclosing said first section and said second section, said stitching section joining said first section to said second section in an overlying relationship, said stitching section blocking flow of inflation fluid from said inflation fluid volume between said first section and said second section; and

a neck portion for connection with an inflation fluid source and a body portion for inflation into a position to protect the vehicle occupant, said neck portion having a plurality of fastener openings for connection with said inflation fluid source, said neck portion being free of said assemblies, said assemblies being disposed in said body portion of said inflatable restraint.

20. An inflatable vehicle occupant restraint such as an air bag for, when inflated, protecting a vehicle occupant, said inflatable restraint having an uninflated condition and an inflated condition, said inflatable restraint comprising:

a first panel having a central portion, an outer peripheral portion, an inner side surface and an outer side surface;

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a second panel having a central portion, an outer peripheral portion, an inner side surface and an outer side surface;

said outer peripheral portions of said first and second panels being sewn together along an outer stitching line to join said first and second panels to form a body portion of said inflatable restraint, said inner side surface of said first panel being presented toward said inner side surface of said second panel;

said central portions of said first and second panels being at least partially spaced apart from each other when said inflatable restraint is in the inflated condition to define an inflation fluid volume between said central portions of said first and second panels;

a plurality of stitching sections joining said central portion of said first panel to said central portion of said second panel at a plurality of spaced apart locations, each one of said plurality of stitching sections being spaced apart from the other ones of said plurality of stitching sections;

each one of said stitching sections enclosing a respective first section of said central portion of said first panel and a respective second section of said central portion of said second panel;

each one of said first sections overlying a corresponding one of said second sections when said inflatable restraint is in the inflated condition;

said stitching sections blocking flow of inflation fluid from said inflation fluid volume between said first sections of said first panel and said second sections of said second panel; and

a neck portion for connection with an inflation fluid source and a body portion for inflation into a position to protect the vehicle occupant, said neck portion having a plurality of fastener openings for connection with said inflation fluid source, said neck portion being free of said assemblies, said assemblies being disposed in said body portion of said inflatable restraint.

* * * * *

EXHIBIT C



US005782489A

United States Patent [19]

LaLonde et al.

[11] **Patent Number:** 5,782,489[45] **Date of Patent:** Jul. 21, 1998[54] **AIR BAG WITH ADHESIVE AT SEAMS**

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[21] **Appl. No.:** 701,828[22] **Filed:** Aug. 23, 1996[51] **Int. Cl.⁶** B60R 21/20[52] **U.S. Cl.** 280/743.1[58] **Field of Search** 280/743.1[56] **References Cited****U.S. PATENT DOCUMENTS**

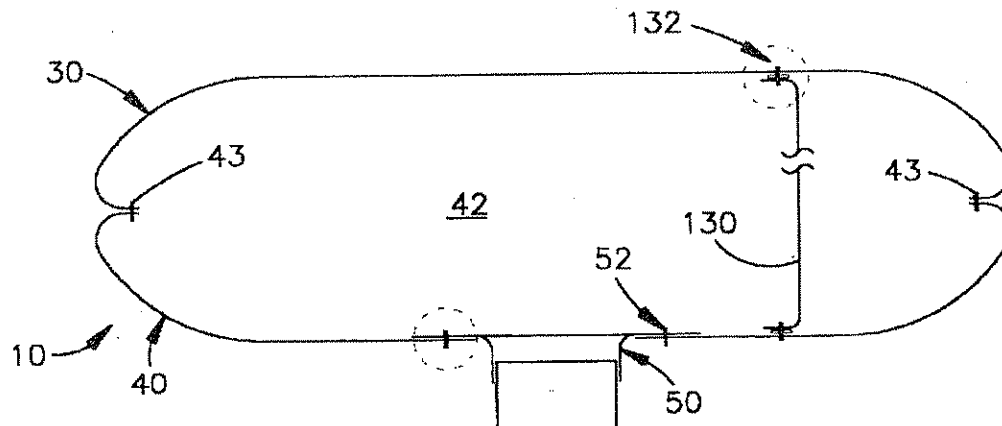
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Attorney, Agent, or Firm—Tarolli, Sundheim, Covell,
 Tummino & Szabo

[57] **ABSTRACT**

An air bag (10) comprises an adhesive material (60) located between and interconnecting first and second panels (40, 50). A stitching section (70) extends through the first panel (40) and through the adhesive material (60) and through the second panel (50) to block relative movement between the first and second panels. The adhesive material resists separation of the yarns (56, 58) of the panels (40, 50). The adhesive material (60) also fills thread openings (94) in the second panel (50) around the stitching section (70).

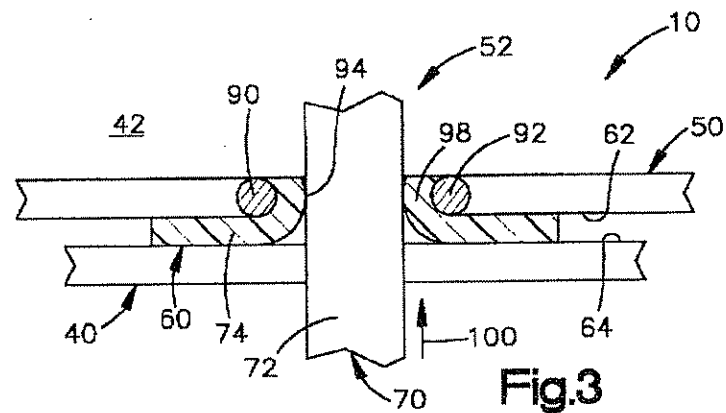
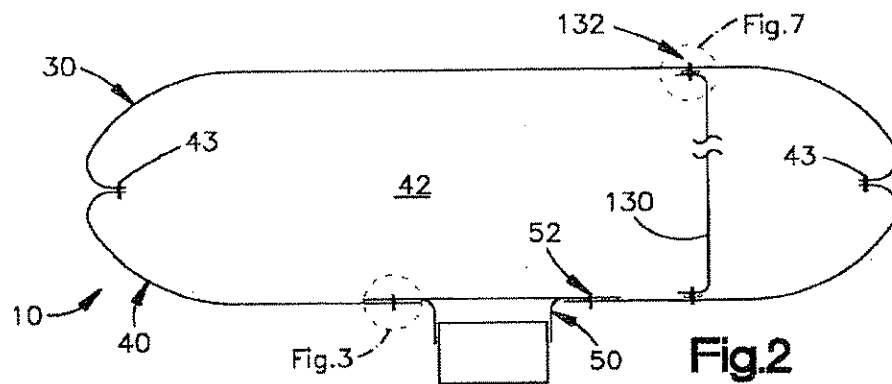
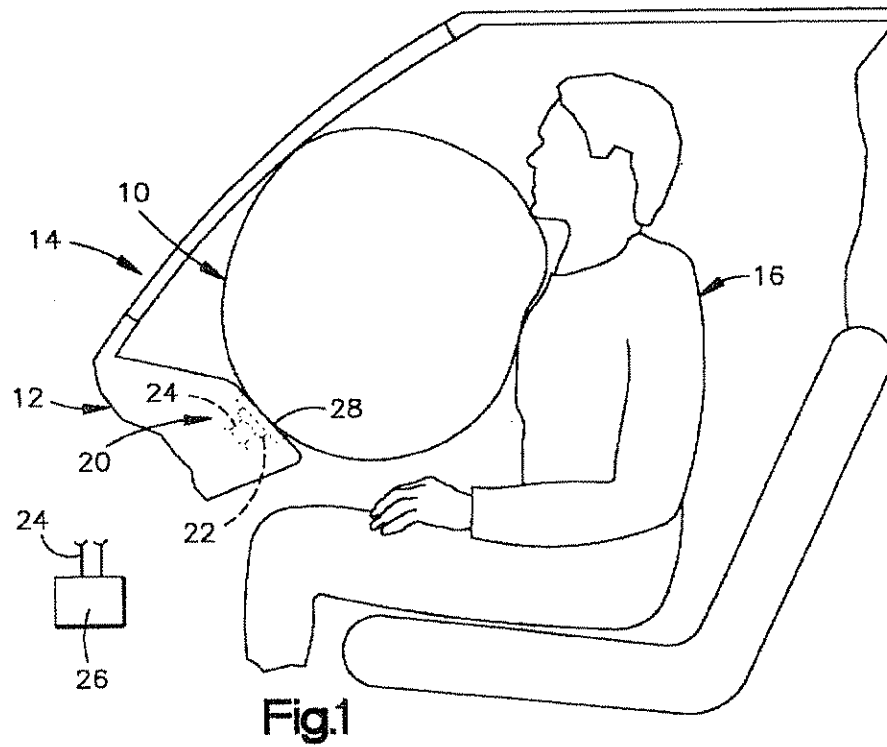
13 Claims, 2 Drawing Sheets

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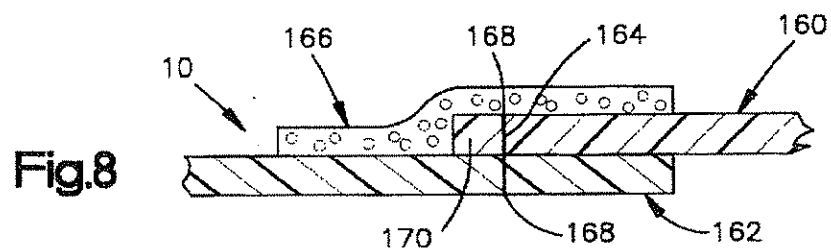
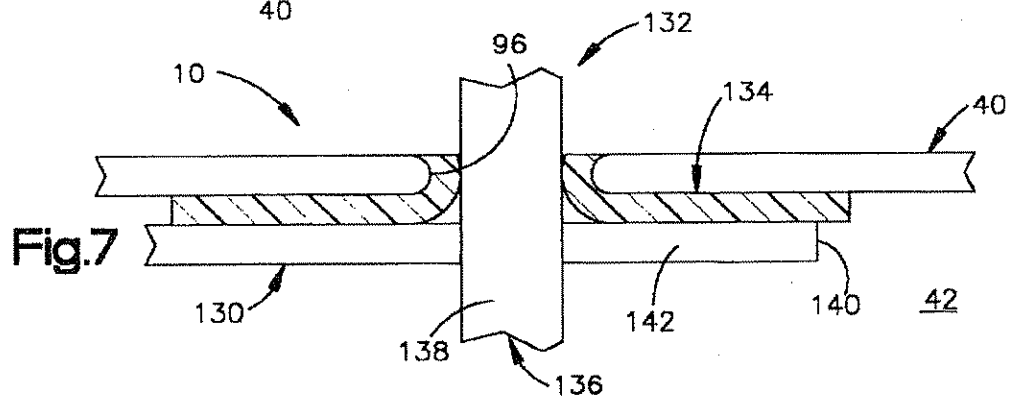
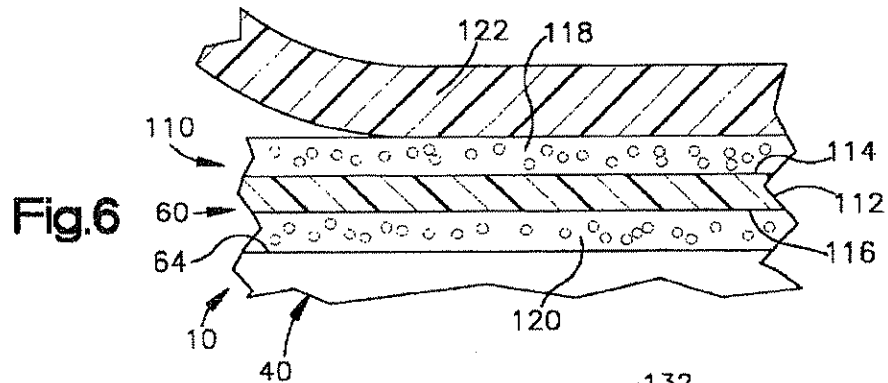
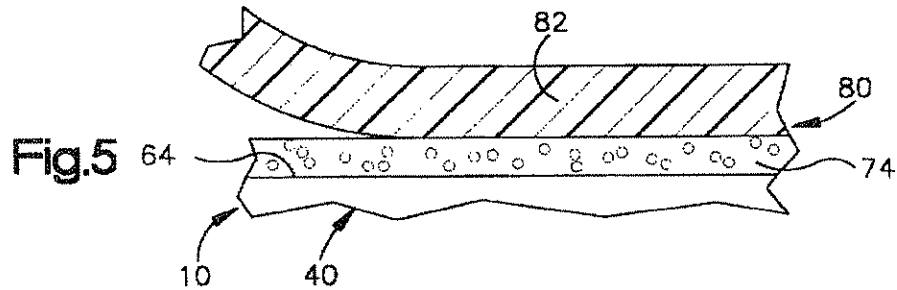
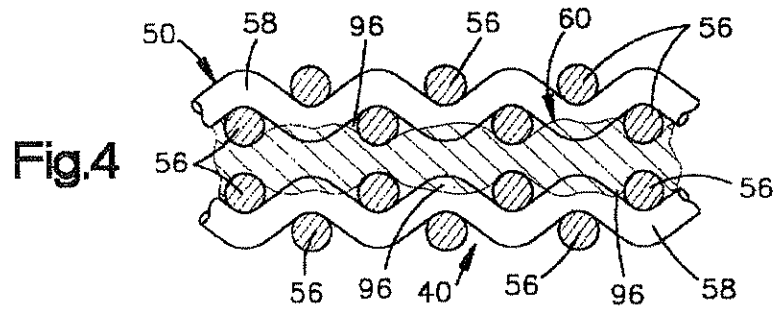


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AIR BAG WITH ADHESIVE AT SEAMS**BACKGROUND OF THE INVENTION****1. Technical Field**

The present invention relates to a vehicle safety apparatus and, in particular, relates to an inflatable vehicle occupant protection device, such as an air bag, for helping to protect a vehicle occupant.

2. Description of the Prior Art

It is known to inflate an air bag to help protect a vehicle occupant in the event of an impact to a vehicle of a magnitude above a predetermined threshold. The air bag is stored in a deflated condition, together with an inflator, in the instrument panel of the vehicle, for example. In the event of an impact to the vehicle of a magnitude above the predetermined threshold, the inflator is actuated, and the air bag is inflated into a position adjacent to the vehicle occupant. The air bag can help to protect the vehicle occupant from forcefully striking or being struck by parts of the vehicle.

The air bag is typically made from a plurality of fabric material panels which are sewn together with one or more stitching sections along one or more seams. The panels are commonly made from a woven material, that is, a material including a plurality of yarns which are woven together to form the panel. When the air bag is inflated, a substantial amount of stress can be placed on the panels. This stress may cause individual yarns of an air bag panel to separate or move apart from adjacent yarns in that panel. This effect is sometimes known as "combing". This effect may be most pronounced at the location of the seams of the air bag. If the yarns separate from each other, inflation fluid from the inflator can flow between the yarns and cause erosion of the yarns. Such erosion can lead to weakening of the fabric.

SUMMARY OF THE INVENTION

The present invention is an inflatable vehicle occupant protection device for helping to protect an occupant of a vehicle. The protection device is inflatable from a deflated condition to an inflated condition by inflation fluid from an inflation fluid source. The protection device comprises a first panel having a first side surface and a second panel having a second side surface overlying the first side surface on the first panel. An adhesive material is located between the first and second side surfaces and interconnects the first and second panels of the protection device. The protection device includes a stitching section comprising a plurality of stitches which extend through the first panel and through the adhesive material and through the second panel to block relative movement between the first and second panels.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the following description of the invention with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic view of a vehicle seat and an air bag module including an air bag constructed in accordance with the present invention, showing the air bag in an inflated condition;

FIG. 2 is a schematic view of the air bag of FIG. 1;

FIG. 3 is a schematic sectional view of a portion of a first seam in the air bag of FIG. 1;

FIG. 4 is an enlarged schematic view of a portion of the seam of FIG. 3;

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FIG. 5 is a schematic view showing one method of applying adhesive to a seam in the air bag of FIG. 1;

FIG. 6 is a schematic view similar to FIG. 5 showing a second method of applying adhesive to a seam in the air bag of FIG. 1;

FIG. 7 is view similar to FIG. 3 showing a portion of a second seam in the air bag of FIG. 1; and

FIG. 8 is a schematic sectional view of a portion of a third seam of the air bag of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention relates to a vehicle occupant protection device which is inflatable to help protect an occupant of a vehicle. The present invention is applicable to various inflatable protection device constructions. As representative of the present invention, FIG. 1 illustrates a specific inflatable vehicle occupant protection device 10 of the type commonly known as an air bag. The air bag 10 is illustrated as being inflatable from an instrument panel 12 of a vehicle 14 to help protect an occupant 16 of the vehicle from contact with parts of the vehicle. The air bag 10 could be inflatable from any desired part of the vehicle. Other inflatable vehicle occupant protection devices that can be used in accordance with the present invention include inflatable seat belts, inflatable knee bolsters, inflatable head liners, and knee bolsters operated by inflatable air bags.

The air bag 10 (described below in detail) is part of an air bag module indicated schematically at 20. The module 20 includes, in addition to the air bag 10, an inflator 22. The inflator 22 is connected by lead wires 24 with electric circuitry of the vehicle 14, indicated schematically at 26, which includes a power source, such as the vehicle battery, and a deceleration sensor. A cover (not shown) closes an opening 28 in the instrument panel 12 through which the air bag 10 is inflatable. The cover may form a portion of the vehicle instrument panel 12.

The air bag 10 (FIG. 2) is formed from two separate fabric material panels, that is, a front panel 30 and a back panel 40. The panels 30 and 40 are sewn together at a side seam 43 to form the air bag 10. The panels 30 and 40 define an inflation fluid volume 42 in the air bag 10. A tubular attachment panel or retainer panel 50 (FIG. 2) connects the air bag 10 with the other parts of the module 20. The retainer panel 50 is sewn together with the back panel 40 at a retainer seam 52.

The panels 30, 40 and 50 of the air bag 10 are made from a woven fabric, such as woven nylon. The woven fabric includes a plurality of warp yarns 56 (FIG. 4) which are interwoven with a plurality of fill yarns 58 to form the woven fabric. The fabric is uncoated—that is, it does not have a coating of a fluid impermeable material, as some air bag fabrics do.

The retainer seam 52 (FIGS. 2 and 3) between the retainer panel 50 and the back panel 40 includes a body of adhesive material 60. The body of adhesive material 60 is disposed between a major side surface 62 of the retainer panel 50 and a major side surface 64 of the back panel 40. The retainer seam 52 also includes a stitching section shown schematically at 70. The stitching section 70 is formed in a known manner and includes a plurality of stitches 72 which extend through the retainer panel 50, through the body of adhesive material 60, and through the back panel 40.

The body of adhesive material 60 is formed by applying adhesive in the form of a layer of adhesive 74 either to the retainer panel 50 or to the back panel 40, before the panels

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are placed adjacent to each other and sewn together. The layer of adhesive 74 is preferably applied in the manner shown in FIG. 5. As illustrated schematically in FIG. 5, the layer of adhesive 74 forms a part of an acrylic pressure sensitive transfer film 80 which includes a liner 82 and the adhesive layer 74. One suitable brand of transfer film 80 is sold by Can-Do National Tape Company, Product No. C28601. The adhesive material in this transfer film is a tacky, acrylic, pressure sensitive adhesive having a thickness of about 5 mils. The liner material is 76# bleached lay flat silicone treated kraft paper. The liner is about one-half inch wide. Other liner materials can be used. The transfer film is furnished rolled on a core. This product can be purchased from Tapecco, Inc., Nashville, Tenn. Another suitable brand of transfer film is sold by Avery Dennison Company, Product No. P-26 adhesive.

To apply the adhesive material 74 to the air bag 10, the transfer film 80 is applied to, for example, the major side surface 64 of the back panel 40, prior to placing the back panel in abutting engagement with the retainer panel 50. The liner 82 is then peeled off as shown schematically at the left side of FIG. 5. The layer of adhesive 74 remains on the back panel 40.

The back panel 40 (FIG. 3) is then assembled with the retainer panel 50. The retainer panel 50 overlies and is in abutting engagement with the layer of adhesive 74 on the back panel 40. The layer of adhesive 74 engages the major side surface 64 of the back panel 40 and the major side surface 62 of the retainer panel 50. The layer of adhesive 74 is located between and interconnects the back panel 40 and the retainer panel 50.

The back panel 40 and the retainer panel 50 are, thereafter, sewn together with the stitching section 70. Each stitch 72 of the stitching section 70 comprises a thread portion which extends through the back panel 40, the adhesive material 60 and the retainer panel 50.

When the back panel 40 and the retainer panel 50 are sewn together, a first group of the stitches or threads 72, specifically, the majority of the stitches or threads, pass between adjacent yarns 90 and 92 of the retainer panel, as shown schematically in FIG. 3. At each location where one of the first group of threads 72 passes between the yarns of a panel, a small thread opening, such as the opening designated 94, is created in the fabric. The thread openings 94 around the threads 72 are larger than the naturally occurring openings 96 (FIG. 4) between adjacent interwoven yarns 56 and 58 of the woven fabric material of the air bag 10. The thread openings 94 (FIG. 3) are not completely filled by the threads 72—that is, some open space remains around the threads.

The adhesive material 60 through which the thread 72 extend acts as a filler material and flows into the thread openings 94 to close at least partially the thread openings. Thus, as illustrated schematically in FIG. 3, an annular portion 98 of the adhesive material 60 flows into or is disposed in the thread opening 94. The adhesive material portion 98 is drawn into the thread opening 94 by the needle (not shown) and thread 72 which are moving in the direction 100 during insertion of the thread. The adhesive material portion 98 fills and seals the thread opening 94 around the thread 72.

Some of the adhesive material 60 also flows into the naturally occurring openings 96 (FIG. 4) between the warp and fill yarns 56 and 58 of each of the panels at the seams, to close at least partially those openings. The adhesive material 60 adheres intimately to the warp and fill yarns 56 and 58 of the panels.

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The body of adhesive material 60 at the retainer 52 seam may, alternatively, be formed in the manner shown in FIG. 6. FIG. 6 illustrates schematically a portion of a piece of adhesive tape or transfer film 110 of the type commonly known as "double-sided" or "double-stick" tape. A suitable brand of transfer film 110 is available from the same sources identified above with respect to the transfer film 80.

The transfer film 110 includes a carrier 112 having first and second opposite side surfaces 114 and 116. A first layer of adhesive 118 is disposed on the first side surface 114 of the carrier 112. A second layer of adhesive 120 is disposed on the second side surface 116 of the carrier 112. A liner 122 covers the first layer of adhesive 118.

If the transfer film 110 is used to form the retainer seam 52, the transfer film is applied to the back panel 40 of the air bag 14. The second layer of adhesive 120 is in abutting engagement with the major side surface 64 of the back panel 40. The liner 122 is peeled off as shown schematically in FIG. 6. The second layer of adhesive 120 remains on the air bag 10. The second layer of adhesive 120 supports the carrier 112 and the first layer of adhesive 118.

The retainer panel 50 is then assembled with the back panel 40. The adhesive layers 118 and 120, together with the carrier 112, form the body of adhesive material 60 which is located between and interconnects the back panel 40 and the retainer panel 50. The panels 40 and 50 are, thereafter, sewn together with the stitching section 70. The stitching section 70 extends through the panels 40 and 50 and through the body of adhesive material 60, including the carrier 112 and the two layers of adhesive 118 and 120.

The air bag 10 includes a vent panel 130 illustrated schematically in FIG. 2. The vent panel 130 is sewn between the front panel 30 and the back panel 40 at a seam 132 (FIGS. 2 and 7). Adhesive material 134 is located at the vent panel seam 132. The adhesive material 134 is located between and interconnects the vent panel 130 and the front and back panels 30 and 40, as illustrated schematically in FIG. 7. The adhesive material 134 may be the same as, and formed in the manner as, the adhesive material 60 (FIG. 3).

The vent panel 130 is sewn to the back panel 40 (FIG. 7) with a stitching section 136 including at least one thread portion 138. The stitching section 136 including the thread portion 138 is spaced apart from the edge 140 of the vent panel 130. The portion 142 of the vent panel 130 which is between the stitching section 136 and the edge 140 of the vent panel is commonly called the seam allowance. The seam allowance of a panel sewn in an air bag, such as the air bag 10, typically has a width of from about one half inch to one inch as measured between the panel edge and the stitching section.

In the event of a vehicle emergency situation, such as sudden vehicle deceleration, for which inflation of the air bag 10 is desired to help protect the vehicle occupant 16 (FIG. 1), the deceleration sensor in the vehicle electric circuitry 26 causes electric current to be supplied over the lead wires 24 to the inflator 22. The inflator 22 is actuated, in a known manner, to direct inflation fluid into the retainer panel 50 of the air bag 10. Inflation fluid under pressure from the inflator 22 flows into the inflation fluid volume 42 of the air bag 10 to inflate the air bag. The air bag 10, when inflated, is disposed generally in a position in front of the vehicle occupant 16.

During inflation of the air bag 10, inflation fluid under pressure is directed at the seams of the air bag. At the same time, the force of the inflating air bag 10 places a substantial amount of stress on the seams of the air bag. This stress may

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in some instances tend to urge individual warp yarns 56 or fill yarns 58 of a panel to separate from adjacent yarns in that panel. If such separation occurs, inflation fluid can flow through the panel in an undesirable amount.

The adhesive material in the seams of the air bag 10 helps to minimize separation of the yarns by blocking relative movement of the yarns in the fabric. For example, the adhesive material 60 (FIG. 4) which is in contact with the warp yarns 56 and the fill yarns 58 in the retainer panel 50 resists relative movement of the yarns in the retainer panel at the time of inflation. The adhesive material 60 also resists relative movement of the warp yarns 56 and the fill yarns 58 in the back panel 40. As a result, separation of the yarns of the fabric material of the air bag 10, at the location of the seams of the air bag, is minimized.

The adhesive material which is located in the thread openings of the air bag 10, such as the thread opening 94 (FIG. 3), at the time of inflation, minimizes the flow of inflation fluid through the thread openings. This can help to minimize erosion of the yarns of the air bag 10 at the location of the seams of the air bag.

The adhesive material 134 (FIG. 7) which is disposed between the back panel 40 and the seam allowance 142 of the vent panel 130 prevents the seam allowance from lifting up and moving away from the back panel. This prevents inflation fluid from flowing between the seam allowance 142 and the back panel 40 and, thereby, from reaching the thread portions 138 and the thread openings 96. This blockage of flow of inflation fluid can help to protect the material of the air bag 10 at the location of the seams of the air bag.

FIG. 8 illustrates the use of a layer of adhesive material over a previously sewn seam rather than in a seam prior to sewing. In FIG. 8, two panels 160 and 162 of the air bag 10 are sewn together with a stitching section 164. Each one of the panels 160 and 162 is made from a woven fabric, such as woven nylon, and includes a plurality of warp yarns and fill yarns (not shown in FIG. 8) which are interwoven to form the fabric. The fabric which forms the panels 160 and 162 is uncoated fabric.

A layer of adhesive 166 overlies the stitching section 164 and overlies the sewn portions of the panels 160 and 162. A portion of the material of the adhesive layer 166 flows into the naturally occurring openings (not shown in FIG. 8) between the individual yarns of the panels 160 and 162. The material of the adhesive layer 166 also flows into the thread openings 168 formed in the panels 160 and 162 when the stitching section 164 is added. The adhesive layer 166 overlies the seam allowance portion 170 of the panel 160.

When the air bag 10 is inflated, the adhesive material 166 resists separation of the yarns in the panels 160 and 162 by resisting relative movement of the yarns in the fabric. The adhesive material 166 which is located in the thread openings 168 minimizes or blocks the flow of inflation fluid through the thread openings. The adhesive material 166 can also prevent the seam allowance 170 of the panel 160 from lifting up and moving away from the panel 162.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications in the invention. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

Having described the invention, we claim:

1. An inflatable vehicle occupant protection device for helping to protect an occupant of a vehicle, said protection device being inflatable from a deflated condition to an inflated condition by inflation fluid from an inflation fluid source, said protection device comprising:

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a first panel having a first side surface;

a second panel having a second side surface overlying said first side surface on said first panel;

an adhesive material located between said first and second side surfaces and interconnecting said first and second panels of said protection device; and

a stitching section including a plurality of stitches which extend through said first panel and through said adhesive material and through said second panel to block relative movement between said first and second panels.

2. A protection device as set forth in claim 1 wherein said first panel is made from yarns woven together to form said first panel, said adhesive material being in intimate contact with a plurality of said yarns in said first panel and resisting movement of said plurality of yarns in said first panel relative to each other upon inflation of said protection device.

3. A protection device as set forth in claim 2 wherein said second panel is made from yarns woven together to form said second panel, said adhesive material being in intimate contact with a plurality of said yarns in said second panel and resisting movement of said plurality of yarns in said second panel relative to each other upon inflation of said protection device.

4. A protection device as set forth in claim 1 wherein said adhesive material comprises a carrier strip having first and second opposite side surfaces, a first layer of adhesive on said first side surface of said carrier strip, and a second layer of adhesive on said second side surface of said carrier strip;

said first layer of adhesive being located between and interconnecting said carrier strip and said first panel;

said second layer of adhesive being located between and interconnecting said carrier strip and said second panel.

5. A protection device as set forth in claim 1 wherein said adhesive material comprises a layer of adhesive forming a portion of a transfer tape, said transfer tape further comprising a liner for applying said layer of adhesive to said protection device.

6. A protection device as set forth in claim 1 wherein said adhesive material is a tacky acrylic pressure sensitive adhesive material.

7. A protection device as set forth in claim 1 wherein said first panel is made from a plurality of yarns woven together to form said first panel, said plurality of stitches including a first group of said stitches, each stitch of said first group of said stitches comprising a thread portion which extends through a respective thread opening between adjacent yarns in said first panel, said adhesive material extending into at least some of said thread openings and blocking flow of inflation fluid through said at least some of said thread openings.

8. A protection device as set forth in claim 7 wherein said adhesive material is in intimate contact with said yarns in said first panel and resists movement of said yarns in said first panel relative to each other upon inflation of said protection device.

9. A protection device as set forth in claim 1 wherein said first panel has an edge spaced apart from said stitching section, a seam allowance portion of said first panel extending between said edge and said stitching section, said adhesive material being located between and interconnecting said second panel and said seam allowance portion of said first panel and blocking movement of said seam allowance portion of said first panel in a direction away from said second panel upon inflation of said protection device.

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10. A protection device as set forth in claim 9 wherein said seam allowance portion of said first panel has a width between said edge and said stitching section in the range of from about one half inch to about one inch.

11. An inflatable vehicle occupant protection device for helping to protect an occupant of a vehicle, said protection device being inflatable from a deflated condition to an inflated condition by inflation fluid from an inflation fluid source, said protection device comprising:

- a first panel having a first side surface;
- a second panel having a second side surface overlying said first side surface on said first panel;
- a filler material located between said first and second side surfaces of said first and second panels of said protection device; and
- a stitching section including a plurality of stitches which extend through thread openings in said first panel and

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through said filler material and through said second panel to block relative movement between said first and second panels;

said filler material extending into said thread openings in said first panel and blocking flow of inflation fluid through said thread openings.

12. A protection device as set forth in claim 11 wherein said filler material comprises an adhesive material which interconnects said first and second panels of said protection device.

13. A protection device as set forth in claim 12 wherein said adhesive material is a tacky acrylic pressure sensitive adhesive material.

* * * * *

EXHIBIT D



US006773030B2

(12) **United States Patent**
Fischer

(10) **Patent No.:** **US 6,773,030 B2**
(45) **Date of Patent:** **Aug. 10, 2004**

(54) **AIR BAG WITH VENT**

(75) **Inventor:** **Kurt F. Fischer, Oxford, MI (US)**

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Lyndhurst, OH (US)**

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(51) **Int. Cl.⁷** **B60R 21/30**

(52) **U.S. Cl.** **280/739**

(58) **Field of Search** **280/734, 736,
280/739, 743.2**

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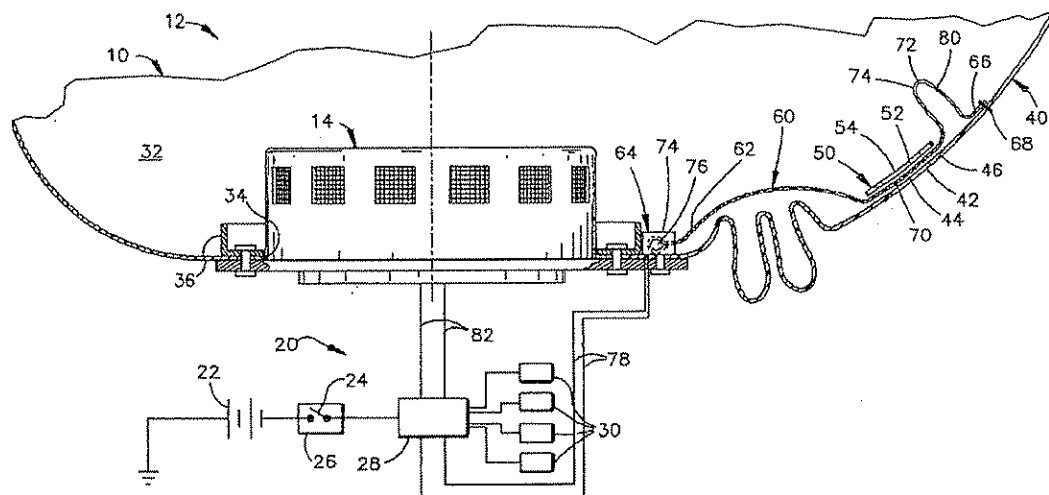
Primary Examiner—Thomas Price

(74) *Attorney, Agent, or Firm*—Tarolli, Sundheim, Covell & Tummino L.L.P.

(57) **ABSTRACT**

An inflatable vehicle occupant protection device (10) has a vent panel (40) defining a first vent opening (42) for enabling flow of inflation fluid out of the device. A vent strap (60) has a second vent opening (72) movable relative to the first vent opening (42). The vent strap (60) has opposite ends (62, 66) that are fixed when the protection device (10) is in the deflated condition. The vent strap (60) has slack (80) due to the length of the strap being greater than the distance between the locations where its opposite ends (62, 66) are fixed. One of the ends (66) of the vent strap (60) moves as the protection device (10) is inflated to remove the slack (80) and move the second vent opening (72) relative to the first vent opening (42).

11 Claims, 4 Drawing Sheets

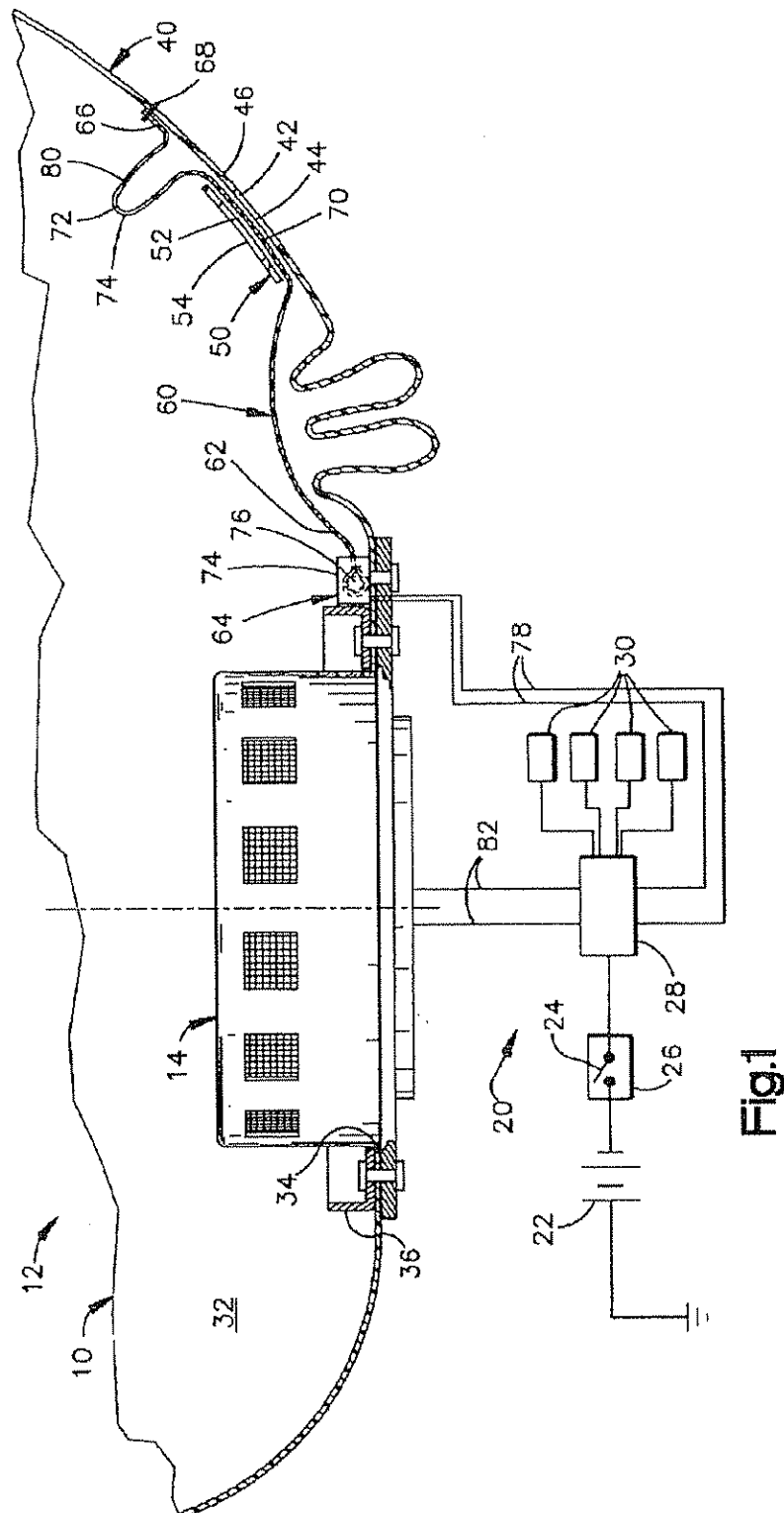


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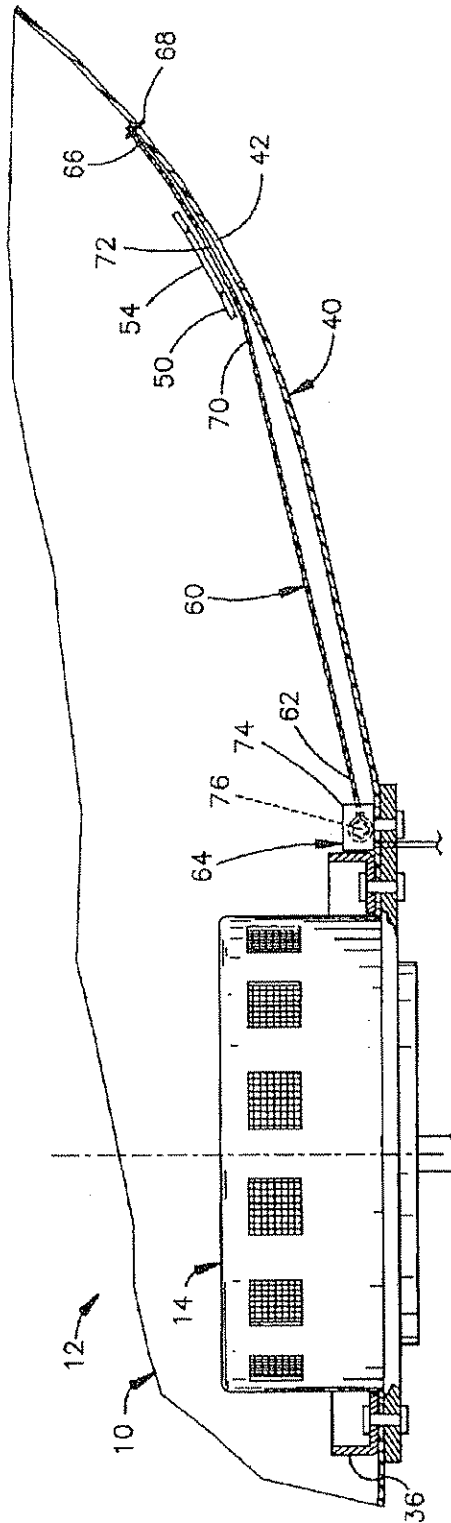


Fig. 2

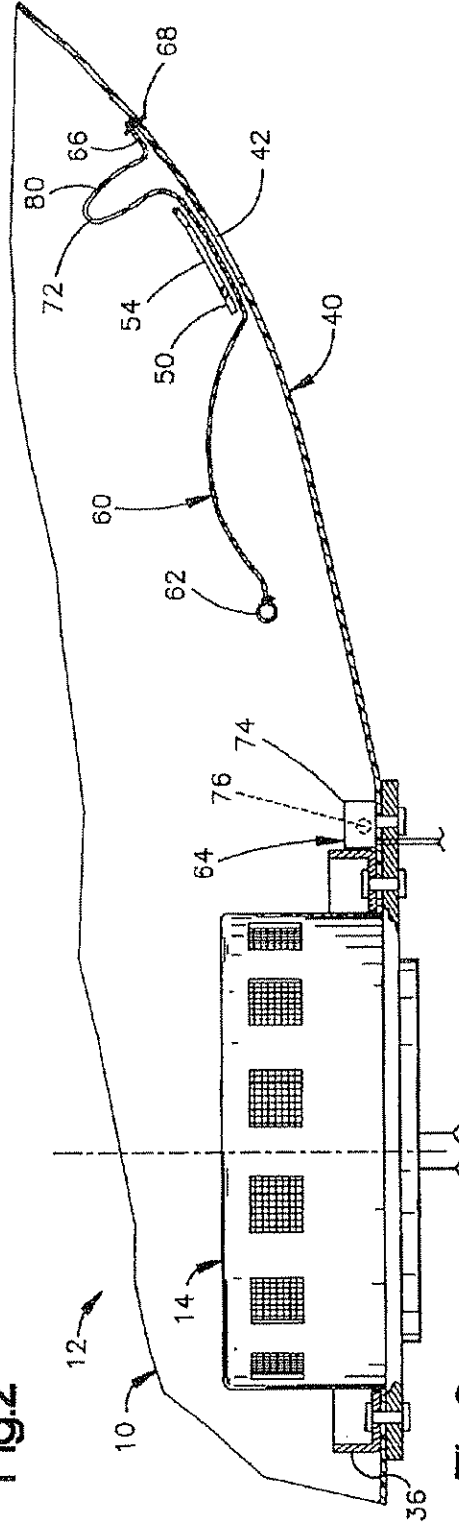


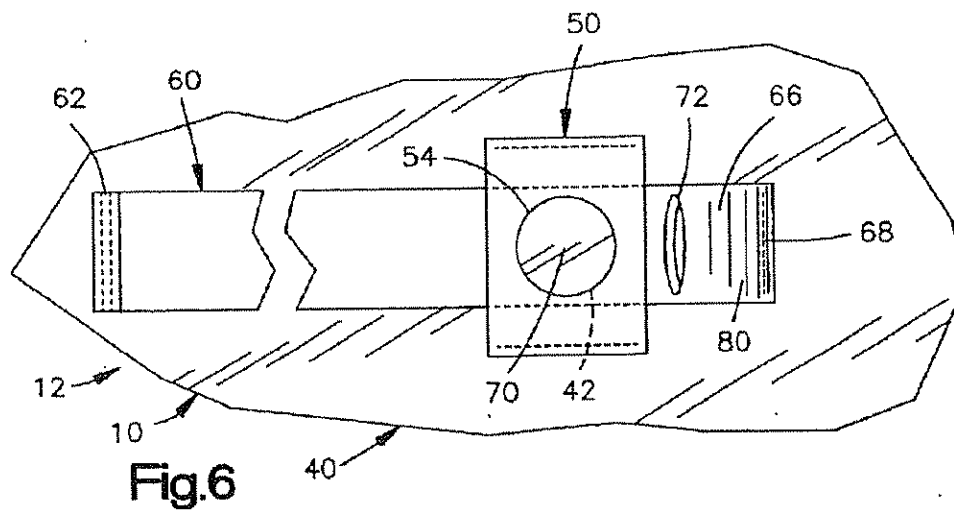
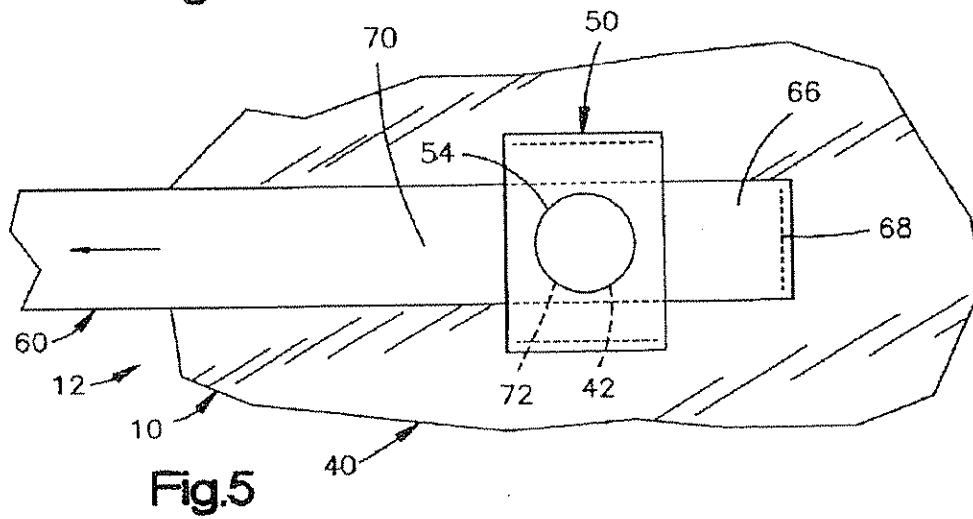
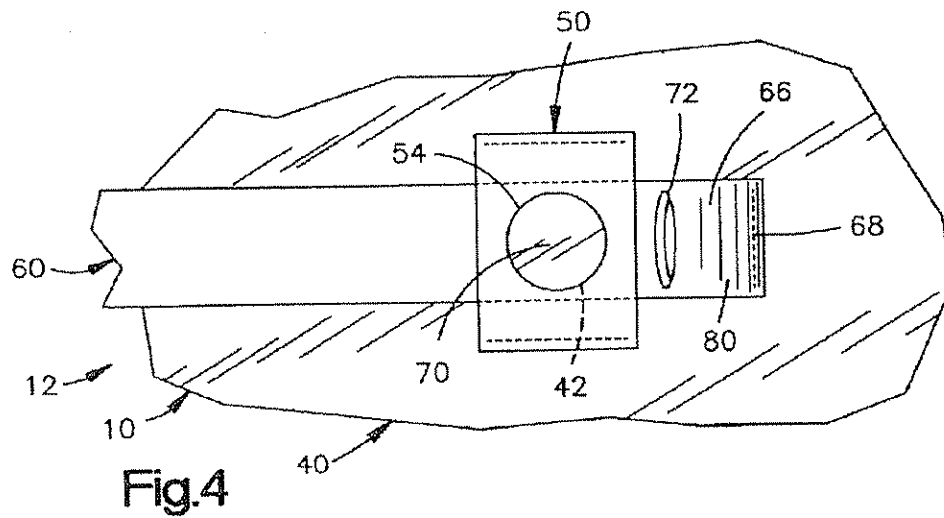
Fig. 3

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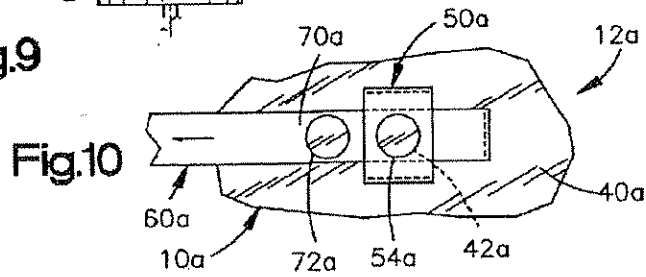
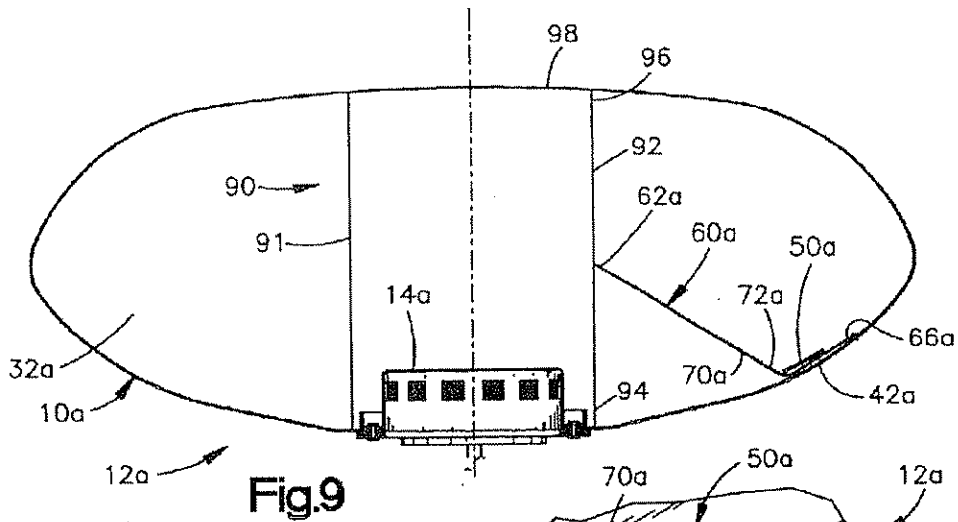
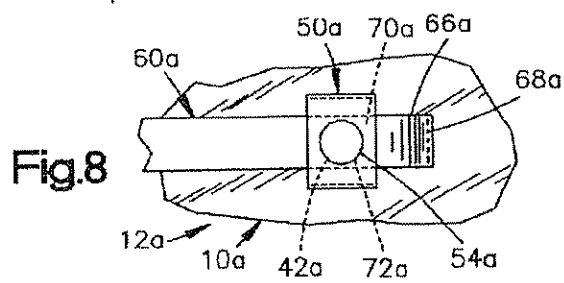
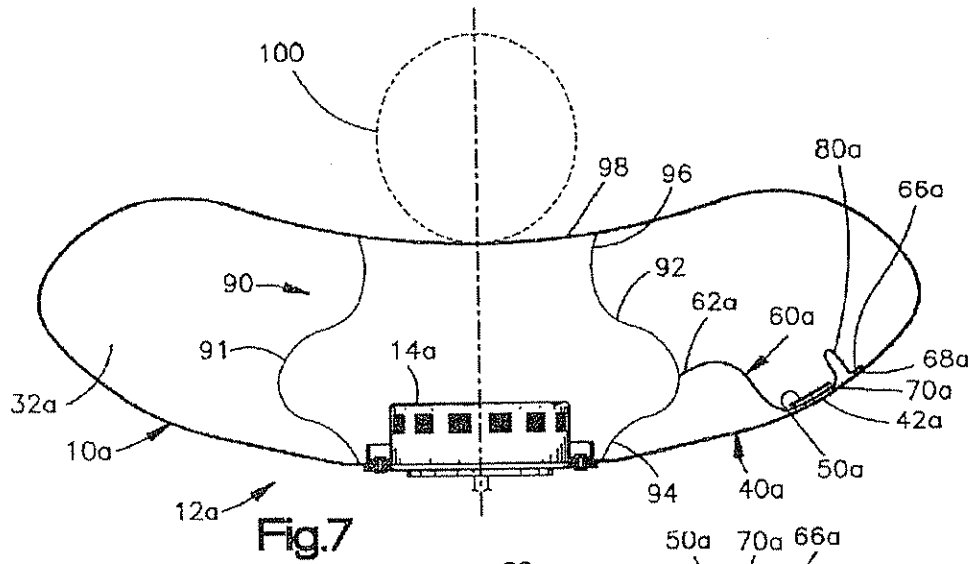


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AIR BAG WITH VENT

BACKGROUND OF THE INVENTION

The present invention relates to a vehicle occupant protection apparatus. In particular, the present invention relates to an air bag having a vent that can be selectively opened to discharge inflation fluid.

DESCRIPTION OF RELATED ART

It is known to provide an air bag with a vent. The vent opens, or is uncovered, when the air bag inflates to help protect a vehicle occupant, to discharge inflation fluid from the inflated air bag. In some air bags, the vent may be selectively opened depending on sensed factors, for example, whether the occupant's seat belt is buckled. U.S. Pat. No. 6,290,257 shows one such air bag. In other air bags, such as the one shown in U.S. Pat. No. 5,405,166, the vent is formed as two openings that are initially aligned so that the vent is initially open and then closes after the internal bag pressure reaches a predetermined amount.

SUMMARY OF THE INVENTION

The present invention relates to a vehicle occupant protection apparatus comprising an inflatable vehicle occupant protection device having a deflated condition and an inflated condition. The device has a vent panel defining a first vent opening for enabling flow of inflation fluid out of the device. The apparatus includes a vent strap having a second vent opening movable relative to the first vent opening. The vent strap has opposite ends that are fixed when the protection device is in the deflated condition. The vent strap has slack due to the length of the strap being greater than the distance between the locations where its opposite ends are fixed. One of the ends of the vent strap moves as the protection device is inflated to remove the slack and move the second vent opening relative to the first vent opening.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the following description of the invention with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view of a portion of a vehicle occupant protection apparatus including an inflatable vehicle occupant protection device in accordance with the present invention;

FIG. 2 is a view similar to FIG. 1 showing the protection device in an inflated condition with the vent open;

FIG. 3 is a view similar to FIG. 1 showing the protection device in an inflated condition with the vent closed;

FIG. 4 is a schematic view of a portion of the inflatable device of FIG. 1, enlarged to show the vent closed;

FIG. 5 is an enlarged schematic view similar to FIG. 4 of a portion of FIG. 2 showing the vent open;

FIG. 6 is an enlarged schematic view similar to FIG. 4 of a portion of FIG. 6 showing the vent closed;

FIG. 7 is a view similar to FIG. 1 of a portion of a vehicle occupant protection apparatus including an inflatable vehicle occupant protection device in accordance with a second embodiment of the present invention, showing the vent open;

FIG. 8 is an enlarged schematic view of a portion of the inflatable device of FIG. 7;

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FIG. 9 is a view similar to FIG. 7 showing the protection device in an inflated condition with the vent closed; and

FIG. 10 is a view similar to FIG. 8 of a portion of the device of FIG. 9.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a vehicle occupant protection apparatus. In particular, the present invention relates to an air bag having a vent that can be selectively opened to discharge inflation fluid. As representative of one embodiment of the present invention, FIG. 1 illustrates a portion of an inflatable vehicle occupant protection device in the form of an air bag 10. Other vehicle occupant protection devices that can be used in accordance with the invention include, for example, inflatable seat belts, inflatable knee bolsters, inflatable head liners, inflatable side curtains, and knee bolsters operated by inflatable air bags.

The air bag 10 forms part of a vehicle occupant protection apparatus 12. The apparatus 12 includes an inflator 14 for inflating the air bag 10. The inflator 14 may contain a stored quantity of pressurized inflation fluid and an ignitable material for heating the inflation fluid. The apparatus 12 alternatively could include an inflator 14 that uses the combustion of gas generating material to generate inflation fluid in the form of gas to inflate the air bag 10, or an inflator that contains only a stored quantity of pressurized inflation fluid for inflating the air bag.

The apparatus 12 includes vehicle electric circuitry indicated schematically at 20 (FIG. 1). The vehicle electric circuitry 20 controls the operation of the inflator 14. The vehicle electric circuitry 20 includes a power source 22, which is preferably the vehicle battery and/or a capacitor, and a normally open switch 24. The switch 24 is part of a collision sensor 26, which senses a condition indicating the occurrence of a vehicle collision. The collision-indicating condition may comprise, for example, sudden vehicle deceleration caused by a collision. The vehicle electric circuitry 20 further includes a controller, or control module, 28 for controlling the operation of the vehicle electric circuitry, and a sensor assembly 30.

The sensor assembly 30 includes one or more sensors that generate one or more control signals useful in determining whether to inflate the air bag 10 with maximum speed and force when a vehicle collision is sensed. For example, the sensor assembly 30 may include an occupant position sensor that generates a control signal indicative of the position of a vehicle occupant in the interior of a vehicle. The sensor assembly 30 may also include a buckle switch for generating a control signal indicative of a buckled or unbuckled condition of a seat buckle assembly of the vehicle. The sensor assembly 30 may also include one or more of the following: a sensor that senses the presence of a rearward-facing child seat, a weight sensor, a belt tension sensor, an occupant size sensor, a module temperature sensor, or a crash severity sensor.

The air bag 10 is preferably made from a flexible fabric material, such as woven nylon. The air bag 10 can alternatively be made from a non-woven material, such as plastic film. The air bag 10 has a generally pillow-shaped configuration when fully inflated and is designed for a driver-side application. The invention is applicable to air bags 10 that are used in other locations, for example, passenger side air bags or side impact air bags.

The air bag 10 defines an inflation fluid volume 32 for receiving inflation fluid from the inflator 14. The air bag 10

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has an inflation fluid opening 34 for receiving inflation fluid from the inflator 14 to inflate the air bag 10. The air bag 10 is secured to the inflator 14 by a retainer or retaining ring shown partially at 36. The assembly of the air bag 10, retainer 36, and inflator 14 is fixed in position in the vehicle by, for example, a mounting plate (not shown).

A portion of the air bag 10 has a vent for discharging inflation fluid from the inflation fluid volume 32 of the air bag 10. In the illustrated embodiment, the air bag portion is a vent panel 40 having a first vent opening 42. The first vent opening 42 has a circular configuration centered on a point 44. The first vent opening 42 is defined by a portion 46 of the vent panel 40 that extends around and encloses the first vent opening.

The apparatus 12 includes a strap retainer 50 disposed adjacent the first vent opening 42, on the interior of the vent panel 40. The strap retainer 50 may be made from the same flexible fabric material as the air bag 10. In the illustrated embodiment, the strap retainer 50 is a short piece of material that is sewn to the inside of the vent panel 40, leaving a small gap 52 between them. The strap retainer 50 has an opening 54 that is aligned with the first vent opening 42 in the vent panel 40, so that inflation fluid can flow out of the inflation fluid volume 32 through the two openings. The opening 54 in the strap retainer 50 is preferably the same size, or about the same size, as the first vent opening 42 in the vent panel 40.

The apparatus 10 includes a vent member for selectively closing and opening the first vent opening 42 in the air bag 10. Vent members in accordance with the present invention may take many different forms. In the illustrated embodiment, the vent member is a vent strap 60, which is a narrow, elongate piece of material. The vent strap 60 may be made from the same material as the air bag 10, or may be made from a different material.

The vent strap 60 has a first end portion 62 that is fixed to a holding mechanism 64 adjacent the inflator 14, in a manner described below. An opposite second end portion 66 of the vent strap 60 is fixed to the vent panel 40 by sewing with a stitching section 68 adjacent the first vent opening 42 in the air bag 10. The first vent opening 42 is located between the stitching section 68 and the inflator 14.

The vent strap 60 includes an intermediate portion, or control portion 70, disposed intermediate the first and second end portions 62 and 66. The control portion 70 of the vent strap 60 is disposed adjacent the first vent opening 42 in the air bag. The control portion 70 of the vent strap 60 is movable by sliding through the gap 52 between the strap retainer 50 and the vent panel 40 of the air bag 10, as can be seen from a comparison of FIGS. 1 and 2 and a comparison of FIGS. 4 and 5.

The control portion 70 of the vent strap 60 defines a second vent opening 72 (FIG. 2). The second vent opening 72 has a circular configuration centered on a point 74, and is preferably the same size, or about the same size, as the first vent opening 42 in the vent panel 40. The control portion 70 of the vent strap 60 extends around and encloses the second vent opening 72.

The vent strap 60 has a first position relative to the vent panel 40, as illustrated in FIGS. 2 and 5, in which the vent is open when the air bag 10 is inflated. Specifically, when the vent strap 60 is in the first position, the second vent opening 72 in the vent strap 60 is aligned with and overlies the first vent opening 42 in the vent panel 40. The alignment of the first and second vent openings 42 and 72 enables flow of inflation fluid out of the air bag 10 through the first vent opening 42.

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The vent strap 60 has a second position relative to the vent panel 40, as illustrated in FIGS. 3 and 6, in which the vent is closed when the air bag 10 is inflated. Specifically, when the vent strap 60 is in the second position, the second vent opening 72 in the vent strap is spaced laterally from and not aligned with the first vent opening 42 in the vent panel 40. As a result, the material of the control portion 70 of the vent strap 60 overlies the first vent opening 42, and blocks flow of inflation fluid out of the air bag 10 through the first vent opening.

The holding mechanism 64, which forms part of the occupant protection apparatus 12, is located adjacent to the inflator 14. The holding mechanism 64 is fixed in position relative to the inflator 14, and is thus a fixed portion of the apparatus 12. The holding mechanism 64 could take a form other than that shown in the drawings. In the illustrated embodiment, the holding mechanism 64 includes a solenoid 74 having a movable pin or part 76. The first end portion 62 of the vent strap 60 is looped around, or otherwise connected with or fixed to, the pin 76 of the solenoid 74. The solenoid 74 is electrically actuable over lead wires 78 (FIG. 1). The lead wires 78 are connected with the controller 28 of the vehicle electric circuitry 20. Upon actuation of the solenoid 74, the pin 76 is movable in a direction into and out of the plane of the paper, as viewed in FIG. 3, to release the first end portion 62 of the vent strap 60 for movement away from the inflator 14.

FIG. 1 shows the air bag 10 in a deflated and unfolded condition, with the vent panel 40 of the air bag 10 spaced apart from the holding mechanism 64. It should be understood that when the air bag 10 is in a deflated folded condition, the vent panel 40 of the air bag may be closer to or folded adjacent the holding mechanism 64. In any case, there is a substantial amount of slack 80 in the vent strap 60. The slack 80 is present because the length of the vent strap 60 is greater than the distance between the location where the first end portion of the vent strap is fixed to the holding mechanism 64, and the location where the second end portion 66 of the vent strap is fixed to the vent panel 40. In the illustrated embodiment, the slack 80 is provided by a portion of the vent strap 60 that curls up (as best seen in FIGS. 1 and 3) between the strap retainer 50 and the permanent stitching section 68. The slack 80 is not provided by sewing the strap 60 to the vent panel 40 with tear stitching so as to temporarily shorten the strap until the air bag 10 is pressurized beyond a predetermined amount, at which point the tear stitching would release and the strap would extend in length.

If a collision-indicating condition sensed by the collision sensor 26 indicates the occurrence of a collision for which inflation of the air bag 10 may be desired to help protect the occupant of the vehicle, the switch 24 in the collision sensor 26 closes. The controller 28 determines, on the basis of inputs from the sensor assembly 30, whether the air bag 10 should be inflated and, if so, whether the vent 42 should be opened. If the air bag 10 is to be inflated, the controller 28 transmits an actuation signal to the inflator 14 over lead wires 82. When the inflator 14 is actuated, it emits a large volume of inflation fluid into the inflation fluid volume 32 of the air bag 10. The air bag inflates, as shown in FIGS. 2 and 3.

If a determination is made by the controller 28 that the vent 42 is not to be opened, the solenoid 74 is actuated with a signal over the lead wires 78. The actuation of the solenoid 74 causes the pin 76 to be moved to a position in which it no longer holds the first end portion 62 of the vent strap 60 against movement away from the inflator 14.

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As the air bag 10 inflates thereafter, the vent panel 40 and the second end portion 66 of the vent strap 60, which is sewn to the vent panel, move away from the holding mechanism 64. Because the first end portion 62 of the vent strap 60 is not held by the holding mechanism 64, the entire vent strap moves away from the holding mechanism 64 and the inflator 14, along with the vent panel 40 and the strap retainer 50. Because the entire vent strap 60 moves bodily with the vent panel 40, there is no significant force placed on the vent strap that would cause it to move relative to the vent panel. Specifically, there is no significant amount of tensile force placed on the vent strap 60 that would cause the slack 80 in the vent strap to be taken out. Therefore, the vent strap 60 remains in position relative to the vent panel 40, with the material of the control portion 70 covering the first vent opening 42 in the vent panel. The vent 42 remains covered, or closed.

If, on the other hand, the controller 28 determines that the vent 42 should be opened, the solenoid 74 is not actuated. The holding mechanism 64 holds the first end portion 62 of the vent strap 60 against movement away from the holding mechanism and the inflator 14.

As the air bag 10 inflates thereafter, the vent panel 40 moves away from the holding mechanism 64. The force of movement of the vent panel 40 is transmitted into the second end portion 66 of the vent strap 70 through the stitching section 68, attempting to pull the vent strap away from the holding mechanism 64. Because the first end portion 62 of the vent strap 60 is held by the pin 76, the tensile force on the vent strap increases to a level at which the slack 80 is removed from the vent strap and the vent strap is caused to pull through the strap retainer 50. As this occurs, the second vent opening 72 in the vent strap 60 becomes aligned with the first vent opening 42 in the vent panel 40, as seen in FIGS. 2 and 5. The vent 42 is uncovered or opened. The vent 42 opens to an open condition to permit flow of pressurized fluid out of the inflation fluid volume 32 of the air bag 10, through the vent.

FIGS. 7-10 illustrate a portion of a vehicle occupant protection apparatus 12a in accordance with a second embodiment of the invention. Parts of the apparatus 12a that are similar or identical in function to corresponding parts of the apparatus 12 (FIGS. 1-6) are given the same reference numerals with the suffix "a" attached.

The apparatus 12a includes an inflatable vehicle occupant protection device in the form of an air bag 10a. The air bag 10a is similar in construction to the air bag 10 and includes a first vent opening 42a. The air bag 10a also includes a tether 90, that is, an internal device for controlling and/or limiting the amount of inflation of the air bag. In the illustrated embodiment, the tether 90 includes two tether straps 91 and 92 on opposite sides of the inflator 14a. The tether straps 91 and 92 are shown as individual, separate straps, but could alternatively be part of one fabric loop. An inner end portion 94 of the tether strap 92 is fixed adjacent the inflator 14a. An outer end portion 96 of the tether strap 92 is connected with an outer panel 98 of the air bag 10a. When the air bag 10a is in the deflated condition shown in FIG. 7, the tether strap 92 is not pulled tight. When the air bag 10a inflates more fully, as shown in FIG. 9, the tether strap 92 is pulled tight.

The apparatus 12a includes a vent member for selectively closing and opening the first vent opening 42a in the air bag 10a. Vent members in accordance with the second embodiment of the invention may take many different forms. In the illustrated embodiment, the vent member is a vent strap 60a, like the vent strap 60 (FIGS. 1-6).

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The vent strap 60a has a first end portion 62a that is fixed to the tether strap 92. The fixation of the vent strap 60a to the tether strap 92 is preferably accomplished by sewing. The first end portion 62a of the vent strap 60a is fixed to the tether strap 92 at a location intermediate the ends of the tether strap.

An opposite second end portion 66a of the vent strap 60a is fixed to the vent panel 40a of the air bag 10a by sewing with a stitching section 68a adjacent the first vent opening 42a in the air bag 10a. The first vent opening 42a is located between the stitching section 68a and the inflator 14a.

The vent strap 60a includes an intermediate portion, or control portion 70a, disposed intermediate the first and second end portions 62a and 66a. The control portion 70a of the vent strap 60a is disposed adjacent the first vent opening 42a in the air bag. The control portion 70a of the vent strap 60a is movable by sliding through the gap between a strap retainer 50a and the vent panel 40a of the air bag 10a.

The control portion 70a of the vent strap 60a defines a second vent opening 72a (FIGS. 8 and 10). The second vent opening 72a has a circular configuration and is preferably the same size, or about the same size, as the first vent opening 42a in the vent panel 40a. The control portion 70a of the vent strap 60a extends around and encloses the second vent opening 72a.

The vent strap 60a has a first position relative to the vent panel 40a, as illustrated in FIGS. 7 and 8, in which the vent 42a is open. Specifically, when the vent strap 60a is in the first position, the second vent opening 72a in the vent strap is aligned with and overlies the first vent opening 42a in the vent panel 40a. The alignment of the first and second vent openings 42a and 72a enables flow of inflation fluid out of the air bag 10a through the first vent opening 42a.

The vent strap 60a has a second position relative to the vent panel 40a, as illustrated in FIGS. 9 and 10, in which the vent 42a is closed. Specifically, when the vent strap 60a is in the second position, the second vent opening 72a in the vent strap is spaced laterally from and not aligned with the first vent opening 42a in the vent panel 40a. As a result, the material of the control portion 70a of the vent strap 60a overlies the first vent opening 42a, and blocks flow of inflation fluid out of the air bag 10a through the first vent opening.

The vent strap 60a has a substantial amount of slack 80a in it when the air bag 10a is deflated or only partially inflated, as shown in FIGS. 7 and 8. This slack 80a is disposed between the retainer 50a and the stitching section 68a. The vent strap 60a is in the first position whenever the tether strap 92 is not extended enough to pull the slack 80a out of the vent strap.

The air bag 10a is inflatable by the inflator 14a upon receipt of an actuation signal as described above with reference to a the first embodiment of the invention. When the inflator 14a is actuated, it emits a large volume of inflation fluid into the inflation fluid volume 32a of the air bag 10a. The air bag 10a inflates.

If the air bag 10a inflates by less than a certain amount (FIGS. 7 and 8), the outer panel 98 moves away from the inflator 14a by less than a predetermined amount. This might happen, for example, if the air bag 10a when inflating contacts a vehicle occupant (as shown schematically at 100 in FIG. 7) who is positioned relatively close to the inflator 14a. In this case, the tether strap 92 is not stretched out and does not pull on the vent strap 60a sufficiently to remove the slack 80a from the vent strap. The vent strap 60a remains in the first condition. The second vent opening 72a in the vent

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strap 60a stays in alignment with the first vent opening 42a in the vent panel 40a, and the vent remains open, enabling flow of inflation fluid out of the air bag 10a through the first vent opening. This venting of the air bag 10a can reduce the force and pressure with which the air bag inflates.

If the air bag 10a inflates by more than a certain amount (FIGS. 9 and 10), the outer panel 98 moves away from the inflator 14a by a predetermined amount. This movement causes the tether strap 92 to be tensioned, as shown in FIG. 9. At the same time, the vent panel 40a moves away from the inflator 14a because of inflation of the air bag 10a. The distance between the first end portion 62a of the vent strap 60a and the second end portion 66a of the vent strap increases. The slack 80a is pulled out of the vent strap 60a and the vent strap moves from the first condition to the second condition. The second vent opening 72a in the vent strap 60a is moved out of alignment with the first vent opening 42a in the vent panel 40a, and the vent 42a is closed, blocking flow of inflation fluid out of the air bag 10a through the first vent opening.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications in the invention. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

I claim:

1. A vehicle occupant protection apparatus comprising:
 - an inflatable vehicle occupant protection device having a deflated condition and an inflated condition, said device having a vent panel defining a first vent opening for enabling flow of inflation fluid out of said device;
 - a vent strap having a second vent opening movable relative to said first vent opening;
 - said vent strap having opposite first and second ends that are fixed when said protection device is in the deflated condition;
 - said vent strap having slack due to the length of said strap being greater than the distance between the locations where its opposite ends are fixed;
 - one of said ends of said vent strap moving as said protection device is inflated to remove said slack and move said second vent opening relative to said first vent opening;
 - an actuatable holding mechanism for holding said one of said ends of said vent strap and, for when actuated, releasing said one of said ends of said vent strap to permit movement of said one of said ends of said vent strap; and
 - a sensor means for sensing a condition requiring actuation of said holding mechanism to permit movement of said one of said ends of said vent strap.

2. Apparatus as set forth in claim 1 further including an inflator for directing inflation fluid into said protection device to inflate said protection device, said first end of said vent strap being fixed adjacent said inflator and said second end of said vent strap being fixed to said vent panel, said second end of said vent strap moving with said vent panel upon inflation of said protection device away from said inflator when said device inflates.

3. Apparatus as set forth in claim 1 wherein said second vent opening is movable relative to said first vent opening between a first position when said device is in the inflated condition in which said second vent opening is aligned with said first vent opening, and a second position when said device is in the inflated condition in which said second vent opening is not aligned with said first vent opening.

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4. Apparatus as set forth in claim 3 wherein said first and second vent openings are aligned when said device is in the deflated condition thereby to enable flow of inflation through said first vent opening.

5. Apparatus as set forth in claim 3 wherein said first and second vent openings are not aligned when said device is in the deflated condition thereby to block flow of inflation through said first vent opening.

6. Apparatus as set forth in claim 1 further comprising a tether in said protection device, said first end of said vent strap being fixed to said tether, said tether being tensioned upon inflation of said protection device beyond a predetermined amount to remove said slack from said vent strap to cause said second vent opening to move relative to said first vent opening.

7. Apparatus as set forth in claim 6 further including an inflator for inflating said protection device, and wherein said first end of said vent strap is fixed to an intermediate portion of said tether at a location spaced apart from said inflator.

8. A vehicle occupant protection apparatus comprising:

- an inflatable vehicle occupant protection device having a deflated condition and an inflated condition, said device having a vent panel defining a first vent opening for enabling flow of inflation fluid out of said device;

- a vent strap having a second vent opening movable relative to said first vent opening;

- said vent strap having opposite first and second ends that are fixed when said protection device is in the deflated condition;

- said vent strap having slack due to the length of said strap being greater than the distance between the locations where its opposite ends are fixed;

- one of said ends of said vent strap moving as said protection device is inflated to remove said slack and move said second vent opening relative to said first vent opening;

- sensor means for sensing a condition requiring venting of inflation fluid from said device when said device inflates; and

- a holding mechanism having a first condition in response to said sensor means sensing a condition requiring venting of inflation fluid from said device and having a second condition in response to said sensor means not sensing a condition requiring venting of inflation fluid from said device;

- said holding mechanism when in the first condition holding said second end of said vent strap with said second vent opening in the first position thereby enabling flow of inflation fluid out of said device through said first vent opening;

- said holding mechanism when in the second condition releasing said second end of said vent strap for movement with said vent panel with said second vent opening in the second position when said device inflates.

9. A vehicle occupant protection apparatus comprising:

- an inflatable vehicle occupant protection device having a deflated condition and an inflated condition, said device having a vent panel defining a first vent opening for enabling flow of inflation fluid out of said device;

- a vent strap having a second vent opening movable relative to said first vent opening;

- said vent strap having opposite first and second ends that are fixed when said protection device is in the deflated condition;

- said vent strap having slack due to the length of said strap being greater than the distance between the locations where its opposite ends are fixed;

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one of said ends of said vent strap moving as said protection device is inflated to remove said slack and move said second vent opening relative to said first vent opening;

a vent strap retainer fixed to said vent panel adjacent said first vent opening, said vent strap extending between said retainer and said vent panel, said retainer having a third opening aligned with said first vent opening in said vent panel,

said vent strap having a venting position when said device is in the inflated condition in which said second vent opening is aligned with said first vent opening and said third opening thereby enabling flow of inflation fluid out of said device through said first vent opening; and

said vent strap having a blocking position when said device is in the inflated condition in which said second vent opening is not aligned with said first vent opening and said third opening thereby blocking flow of inflation fluid out of said device through said first vent opening;

said vent strap moving between the venting position and the blocking position in response to inflation of said inflatable device.

10. A vehicle occupant protection apparatus comprising:

an inflatable vehicle occupant protection device having a deflated condition and an inflated condition, said device having a vent panel defining a first vent opening for enabling flow of inflation fluid out of said device;

a vent strap having a second vent opening movable relative to said first vent opening;

said vent strap having opposite first and second ends that are fixed when said protection device is in the deflated condition;

said vent strap having slack due to the length of said strap being greater than the distance between the locations where its opposite ends are fixed;

one of said ends of said vent strap moving as said protection device is inflated to remove said slack and

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move said second vent opening relative to said first vent opening;

a tether in said protection device, said first end of said vent strap being fixed to said tether, said tether being tensioned upon inflation of said protection device beyond a predetermined amount to remove said slack from said vent strap to cause said second vent opening to move relative to said first vent opening;

a vent strap retainer for guiding movement of said vent strap relative to said vent panel, said strap retainer and said vent panel defining a gap through which said vent strap is slidable upon inflation of said protection device beyond a predetermined amount.

11. A vehicle occupant protection apparatus comprising:

an inflatable vehicle occupant protection device having an inflatable volume defined at least in part by a panel having an inner surface facing the inflatable volume and an outer surface facing the atmosphere, said inflatable volume having a deflated condition and an inflated condition, said panel defining a first vent opening for directing flow of inflation fluid to the atmosphere;

a vent strap having a second vent opening movable relative to said first vent opening, said first and second vent openings having an aligned condition directing inflation fluid flow to atmosphere and a second condition blocking inflation fluid flow to atmosphere;

said vent strap having opposite first and second ends that are fixed when said protection device is in the deflated condition;

said vent strap having slack due to the length of said strap being greater than the distance between the locations where its opposite ends are fixed;

one of said ends of said vent strap moving as said protection device is inflated to remove said slack and move said second vent opening relative to said first vent opening from one of said conditions to the other of said conditions.

* * * * *

EXHIBIT E



US00687772B2

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Fischer et al.

(10) Patent No.: **US 6,877,772 B2**
(45) Date of Patent: **Apr. 12, 2005**

(54) **AIR BAG MODULE WITH OCCUPANT ENGAGING FLAP**

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(65) **Prior Publication Data**

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(51) Int. Cl.⁷ **B60R 21/16**

(52) U.S. Cl. **280/743.1; 280/730.1**

(58) Field of Search **280/730.1, 732,
280/728.3, 743.1, 731, 743.2**

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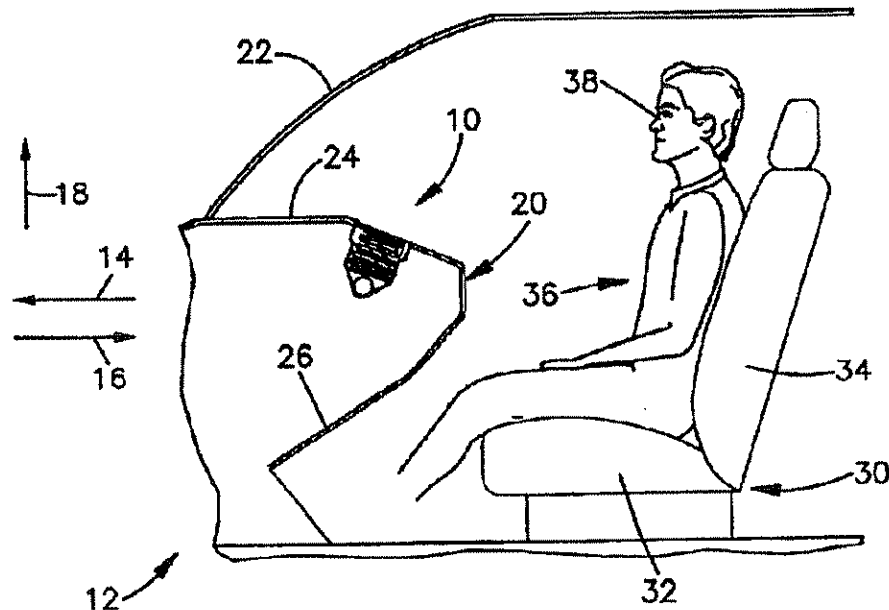
Primary Examiner—Faye M. Fleming

(74) Attorney, Agent, or Firm—Tarolli, Sundheim, Covell
& Tummino L.L.P.

(57) **ABSTRACT**

An apparatus (10) for helping to protect a vehicle occupant (36) includes an inflatable vehicle occupant protection device (44) having a stored, deflated condition and an inflated condition for helping to protect the occupant. An inflator (46) provides inflation fluid to inflate the protection device (44). The apparatus (10) also includes a flap (80) made of fabric material. The flap (80) is stored with the protection device (44). The flap (80) is deployed by inflation of the protection device (44) into a position engaging and covering a head (38) of the vehicle occupant for guiding deployment of the protection device (44) over the head of the occupant.

9 Claims, 4 Drawing Sheets

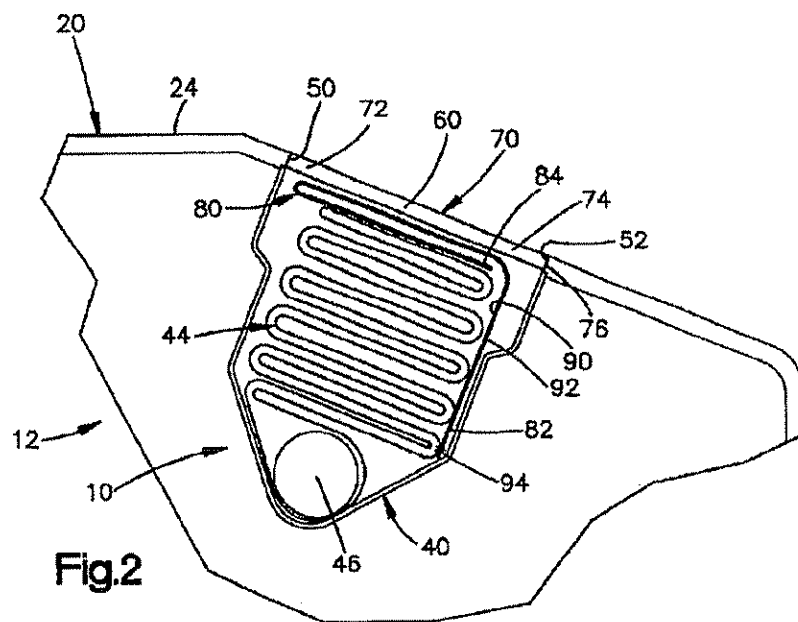
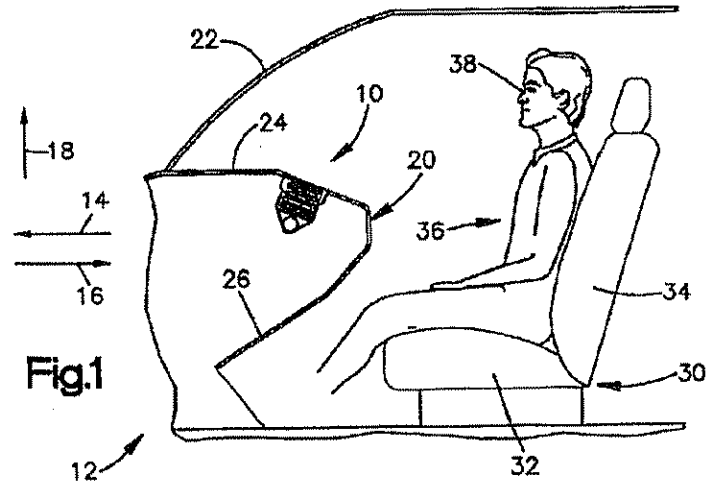


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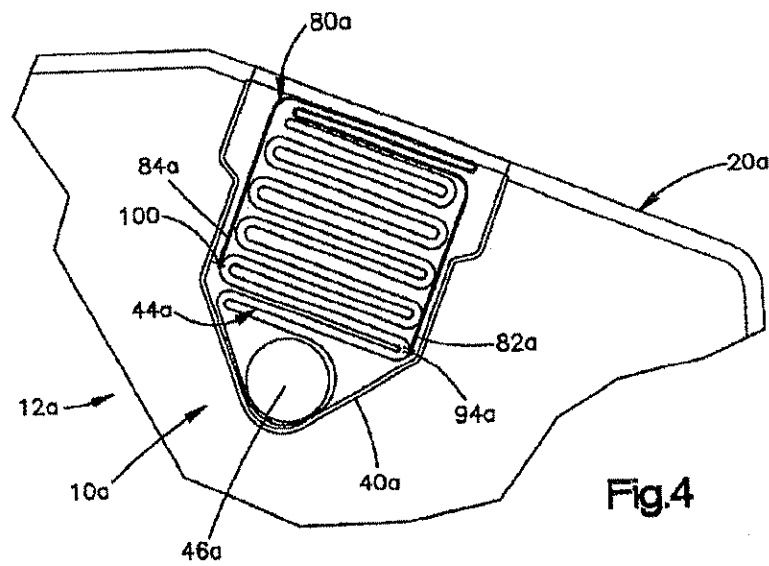
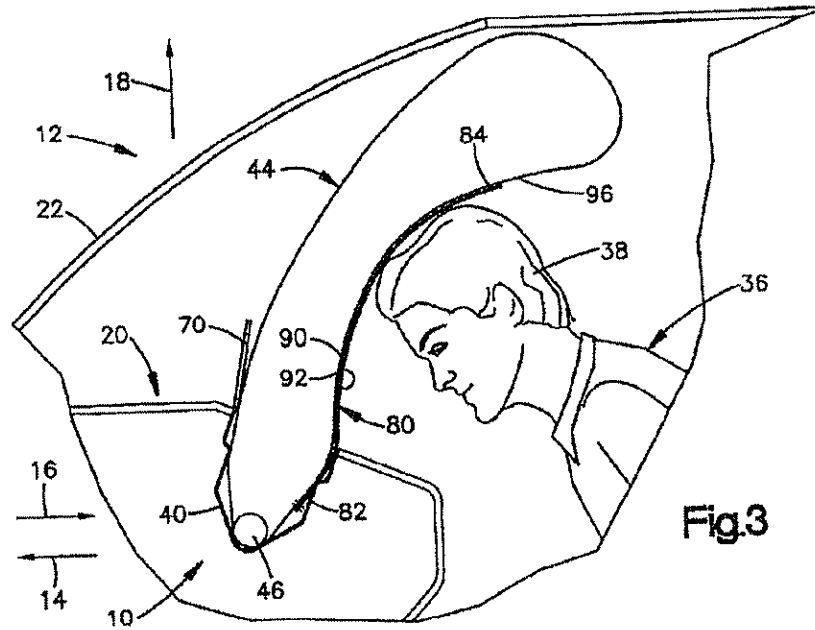


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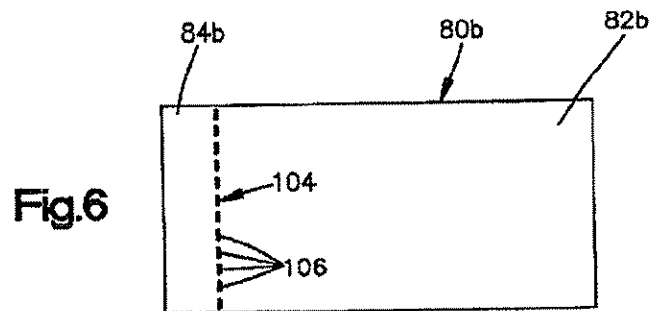
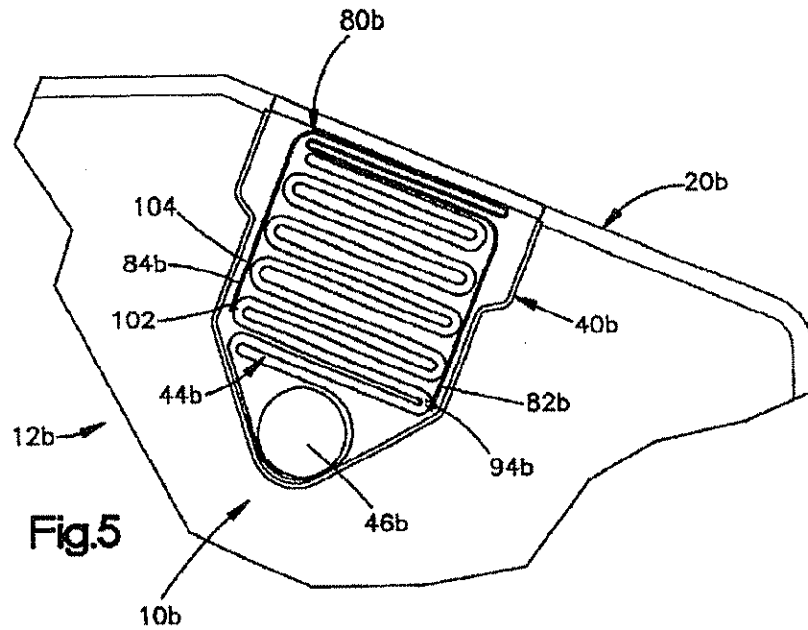


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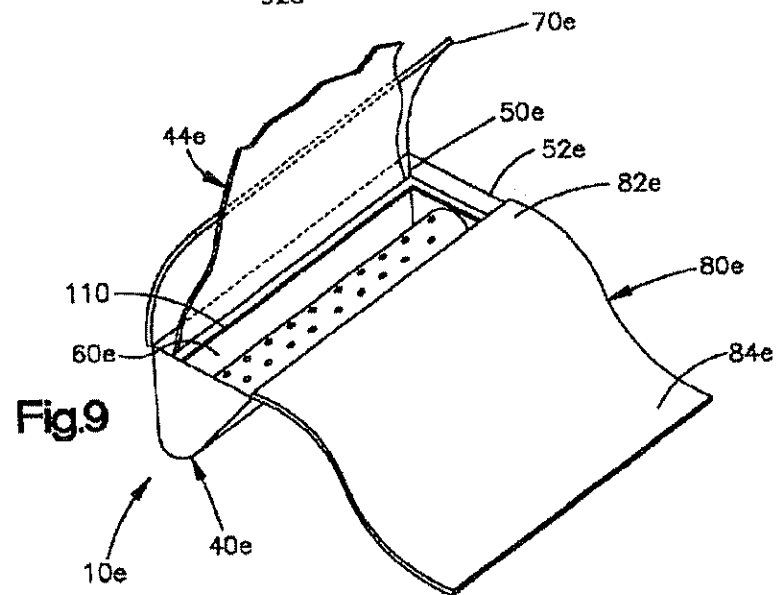
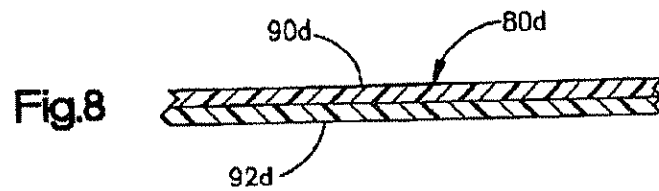
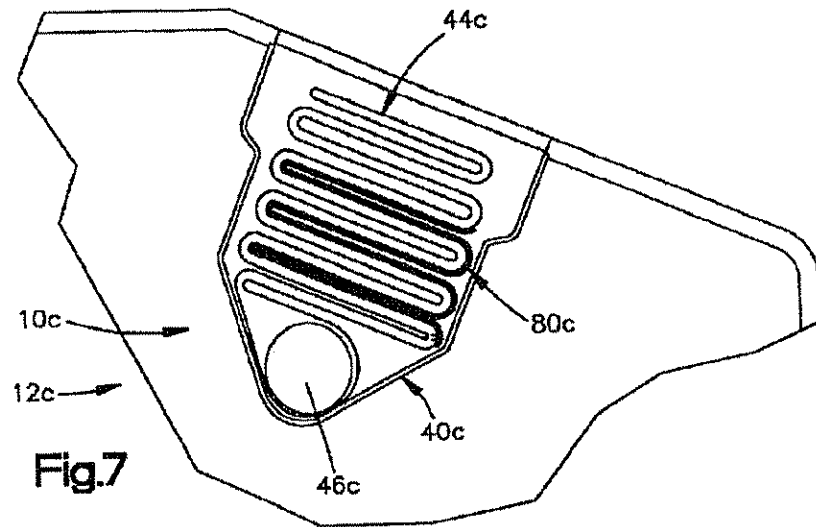


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AIR BAG MODULE WITH OCCUPANT ENGAGING FLAP

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a vehicle occupant protection apparatus and, in particular, to an air bag module including a flap that deploys with an inflating air bag to help protect the vehicle occupant.

2. Description of the Prior Art

It is known to inflate an air bag to help protect a vehicle occupant in the event of a vehicle collision. To help protect a front seat passenger of a vehicle, an air bag is typically mounted in the instrument panel of the vehicle, together with an inflator, at a location forward of the occupant's seat. A deployment opening in the instrument panel is covered by a movable deployment door. The inflator is actuated in the event of a vehicle collision to inflate the air bag through the deployment opening. The deployment door pivots open under the force of the inflating air bag, to enable inflation of the air bag into a position to help protect the vehicle occupant.

If an occupant is in close proximity to the instrument panel when the inflator is actuated, the air bag might inflate against the occupant's head and neck, perhaps while moving in an upward direction. This can undesirably increase the loads on the occupant's head and neck.

SUMMARY OF THE INVENTION

The present invention is an apparatus for helping to protect a vehicle occupant. The apparatus comprises an inflatable vehicle occupant protection device having a stored, deflated condition and an inflated condition for helping to protect a vehicle occupant. An inflator provides inflation fluid to inflate the protection device. The apparatus also includes a flap made of fabric material. The flap is stored with the protection device. In the case of the occupant being in close proximity to the instrument panel, the flap is deployed by inflation of the protection device into a position engaging and covering a head of a vehicle occupant for guiding deployment of the protection device over the head of the vehicle occupant.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the following description of the invention with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic illustration of a portion of a vehicle including a vehicle protection apparatus in accordance with a first embodiment of the present invention;

FIG. 2 is an enlarged view of the vehicle protection apparatus of FIG. 1, shown in a condition prior to actuation;

FIG. 3 is a view similar to FIG. 1 showing the protection apparatus of FIG. 1 in a condition after actuation;

FIG. 4 is a view similar to FIG. 2 showing a protection apparatus in accordance with a second embodiment of the present invention;

FIG. 5 is a view similar to FIG. 2 showing a protection apparatus in accordance with a third embodiment of the present invention;

FIG. 6 is a plan view of a flap that forms part of the protection apparatus of FIG. 5;

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FIG. 7 is a view similar to FIG. 2 showing a protection apparatus in accordance with a fourth embodiment of the present invention;

FIG. 8 is a sectional view of a flap that forms part of a fifth embodiment of the present invention; and

FIG. 9 is a perspective view of a protection apparatus in accordance with a sixth embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a vehicle protection apparatus for protecting an occupant of a vehicle in the event of a vehicle collision. The present invention is applicable to various vehicle protection apparatus constructions. As representative of the present invention, FIG. 1 illustrates a vehicle protection apparatus or air bag module 10.

The air bag module 10 is located on the front passenger side of a vehicle 12. A forward direction of travel of the vehicle 12 is indicated by the arrow 14 and the rearward direction of travel is indicated by the arrow 16. A vertically upward direction in the vehicle 12 is indicated by the arrow 18.

The vehicle 12 includes an instrument panel 20, only portions of which are shown. A windshield 22 of the vehicle extends upward and rearward from the forward edge of the instrument panel 20. The instrument panel 20 includes an upper or front portion 24 that slopes downward and rearward from the base of the windshield 22. A lower or rear portion 26 of the instrument panel 20 extends downward and forward from the rear edge of the front portion 24. The instrument panel 20 can be made from a metal substrate and an overlying plastic material covering, but may alternatively be made in any known manner.

The vehicle includes a seat 30 having a seat bottom cushion 32 and a seat back 34. In FIG. 1 there is shown a vehicle occupant 36 seated on the seat 30. The occupant 36 is seated on the seat bottom cushion 32, and is leaning back against the seat back 34. The occupant 36 has a head 38. The occupant 36 and the seat 30 are located rearward of the instrument panel 20 and the air bag module 10.

The vehicle protection apparatus 10 includes a reaction canister or housing 40 (FIG. 2) that is supported on the vehicle instrument panel 20 in a known manner by fasteners (not shown). The housing 40 encloses and supports an air bag indicated schematically at 44 and an inflator indicated schematically at 46. The inflator 46 is a known inflator that, upon actuation, provides inflation fluid to inflate the air bag 44 into a position to help protect a vehicle occupant. The air bag 44 is a known air bag that is folded and stored in a known manner in the housing 40.

The upper portion 24 of the instrument panel 20 has upper and lower edge surfaces 50 and 52, respectively, and side edge surfaces (not shown) that define a deployment opening 60 in the instrument panel 20. In the embodiment shown in FIGS. 1 and 2, the deployment opening 60 faces generally upward and rearward in the vehicle, toward the windshield 22 and the vehicle occupant 36.

The air bag module 10 includes a single door panel 70 that covers substantially the entire deployment opening 60. It should be understood that the module 10 could, alternatively, include more than one door for covering the deployment opening 60. The door panel 70 may be made from a plastic material similar to the covering of the instrument panel 20. The door panel 70 has a forward or upper edge portion 72 disposed closer to the vehicle windshield 22

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and a lower or rear edge portion 74 disposed farther from the windshield, that is, closer to the vehicle occupant. The lower edge portion 74 of the door panel 70 is releasably connected with the lower edge surface 52 on the instrument panel 20 by a rupturable portion or tear seam 76.

The air bag module 10 also includes a flap 80 (FIGS. 2 and 3). The flap 80 is a structure that is located between the air bag 44 and the head 38 of the occupant 36, when the air bag is inflated, as described below. The flap 80 engages and extends over the head 38 of the occupant 36, particularly if the occupant is leaning forward as shown in FIG. 3. The flap prevents the air bag 44 itself from engaging the head of the occupant. The flap 80 acts as a guide to guide the air bag 44 to inflate past the head 38 of the occupant 36 without actually engaging the head of the occupant.

The flap 80 is preferably made from a fabric material, which may be the same material from which the air bag 44 is made. One suitable material is woven nylon, a material that is commonly used to make air bags.

The flap 80 has first and second end portions, or ends, 82 and 84. The flap 80 has first and second opposite major side surfaces 90 and 92 (FIG. 3). In the embodiment illustrated in FIGS. 1-3, the flap 80 is made from a piece of fabric material that is not coated on either side. Therefore, the first and second major side surfaces 90 and 92 of the flap 80 have the same coefficient of friction as each other.

The length of the flap 80 is selected so that it extends over (past the top of) the head 38 of a forward seated occupant 36 when the flap is fully deployed. In one embodiment, the flap 80 is a rectangular piece of material having a width (transversely across the deployment opening 90) of about 300 millimeters, and a length (extending out from the deployment opening) of about 400 millimeters.

The first end portion 82 of the flap 80 is attached to the air bag module 10. In the embodiment illustrated in FIGS. 1-3, the first end portion 82 of the flap 80 is sewn to the air bag 44, at a location near the lower or rearward edge 52 of the deployment opening 60, with a permanent stitching section 94 (FIG. 2). The opposite second end portion 84 of the flap 80 is free—that is, it is not connected with or secured to the air bag module 10, other than through the sewing of the first end portion.

The air bag 44 is folded and/or rolled, and packed into the housing 40. The flap 80, as shown in FIG. 2, is folded over the top of the folded air bag 44. The folded flap 80 is located immediately under the door panel 70. Thus, the flap 80 and air bag 44 are stored together in the housing 40.

In the event of a vehicle collision for which it is desired to inflate the air bag 44, the inflator 46 is actuated in a known manner by a collision sensor (not shown). The inflator 46 directs inflation fluid into the air bag 44. The inflating air bag 44 presses outwardly against the door panel 70 and causes the tear seam 76 to rupture. The door panel 70 pivots about its upper edge portion 72, relative to the instrument panel 20, from the closed condition shown in FIGS. 1 and 2 to the open condition shown in FIG. 3.

The air bag 44 inflates into the inflated condition shown in FIG. 3. When the air bag 44 is inflated, the air bag has a rearward-facing outer surface portion 96 that is presented toward, and is closest to, the vehicle occupant 36.

As the air bag 44 inflates, the air bag pushes the flap 80 out of the housing 40, from its stored condition shown in FIG. 2 to an open or operative condition shown in FIG. 3. In this condition, the flap 80 is unfolded and is disposed rearward of the air bag 44. The flap 80 extends between the outer surface portion 96 of the air bag 44, and the vehicle occupant 36.

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The second end portion 84 of the flap 80 is outermost, that is, located farthest from the housing 40. The first major side surface 90 of the flap 80 faces forward, and engages the outer surface portion 96 of the air bag 44. The second major side surface 92 of the flap 80 faces rearward, and is engageable by the occupant 36.

In FIG. 3, the vehicle occupant 36 is shown in a forward position, not seated against the seat back 34 of the vehicle seat 30. In this position, the occupant 36 may be contacted by the air bag 44 as the air bag inflates. If such contact occurs, portions of the inflating air bag 44 may catch on the occupant's chin or other portions of the head 38, and exert undesired upward and rearward directed forces on the occupant's head and/or neck.

The flap 80 helps to minimize such forces. Specifically, the flap 80 engages the head 38 of the vehicle occupant 36. The inflating air bag 44, as it inflates upward and rearward, slides along the first major side surface 90 of the flap 80. The inflating air bag 44 does not contact the occupant's head 38. The first major side surface 90 of the flap 80 presents a relatively smooth and unobstructed surface to the air bag 44. Thus, the flap 80 does not resist the upward movement of the air bag 44 so much as it would be resisted by contact with the vehicle occupant 36. As a result, any force tending to push the head 38 of the occupant 36 up is minimized.

As noted above, the flap 80 is pushed outward and rearward by the inflating air bag 44. If the vehicle occupant 36 is leaning back against the seat back 34 when the air bag 44 inflates, the flap 80 is pushed downward against the lower part 26 of the instrument panel 20, not contacting the occupant 36 at all. If the occupant 36 is neither leaning back against the seat back 34 nor forward against the instrument panel 20 when the air bag 44 inflates, the flap 80 may or may not contact the occupant 36. In any event, the flap 80 does not wave loosely through the air but instead is always pushed by the inflating air bag 44.

FIGS. 4-9 illustrate alternative embodiments of the invention, that are similar in many respects to the embodiment illustrated in FIGS. 1-3. Parts of the air bag modules shown in FIGS. 4-8 that are the same, or similar in function or construction, are given the same reference numerals with an appropriate letter suffix added to distinguish them.

In a second embodiment of the invention that is illustrated in FIG. 4, the second end portion 84a of the flap 80a is sewn to the air bag 44a, with a releasable stitching section 100. The first end portion 82a of the flap 80a is sewn to the air bag 44a with a permanent stitching section 94a. When the air bag 44a inflates (not shown), the releasable stitching section 100 releases (tears), freeing the second end portion 84a of the flap 80a and allowing the flap to move into position between the inflating air bag and the occupant.

In a third embodiment as illustrated in FIGS. 5 and 6, the first end portion 82b of the flap 80b is sewn to the air bag 44b with a permanent stitching section 94b, and the second end portion 84b of the flap is also sewn to the air bag with a permanent stitching section 102. The flap 80b has a rupturable portion 104 between the first and second end portions 82b and 84b. The rupturable portion 104 may be formed as a line of perforations 106. The rupturable portion 104 is located near the second end portion 84b of the flap 80b. When the air bag 44b inflates, the rupturable portion 104 of the flap 80b ruptures. The air bag 44b tears along the line of perforations 106, freeing the flap 80b to move into position between the inflating air bag 44b and the head of the occupant.

In a fourth embodiment as illustrated in FIG. 7, the flap 80c is folded and/or rolled with the air bag 44c in the

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housing 40c. Specifically, the air bag 44c is Z-folded, with the flap 80c folded in with the air bag. If, alternatively, the air bag 44c is rolled toward the forward portion of the module 10c (nearer the windshield), the flap 80c is rolled with the air bag. When the air bag 44c inflates, it unrolls or unfolds, and the flap 80c unrolls or unfolds with the air bag.

In a fifth embodiment of the invention illustrated in FIG. 8, one of the side surfaces of the flap 80d is coated or otherwise treated or formed to have an increased coefficient of friction. Specifically, the second major side surface 92d of the flap 80d, which is presented toward and is engageable by the vehicle occupant, is coated with or formed of a material to make it "stickier"—that is, to provide a higher coefficient of friction. The coating material could be silicone, or rubber, or another such suitable material.

Any one of the embodiments can include a coated flap as in FIG. 8. When the flap 80d is deployed, for example as in FIG. 3, the uncoated first major side surface 90d of the flap is presented forward, away from the occupant, toward the inflating air bag itself. This surface 90d is engaged by the outer surface portion of the air bag as it inflates upward past the occupant's head. This surface 90d is relatively smooth and slick, so that as a result, the air bag inflates smoothly upward, without getting caught on the flap 80d or on the occupant. The stickier second major side surface 92d of the flap 80d contacts the occupant, and helps keep the flap in contact with and in position against the occupant's head. Because the flap 80d stays in position on the occupant, the inflating air bag can slide over the relatively slippery first major side surface 90d of the flap and go up over the occupant's head as described above.

FIG. 9 illustrates another embodiment of the invention, in which the flap 80e is attached to the housing 40e or to another part of the module 10e than the air bag 44e. This attachment could be done by rivets, or with a retaining ring, or in another suitable manner. In the module 10e, the air bag 44e is attached to the housing 40e by a retainer or retaining ring 110 that extends completely around the deployment opening 60e. The retaining ring 110 secures the air bag 44e to the housing 40e. Also, the first end portion 82e of the flap 80e is secured to the housing 40e by the retaining ring 110. FIG. 9 also illustrates how, in any of the embodiments of the invention, the flap extends from the rearward or lower edge of the deployment opening of the module.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications in the invention. For example, the invention is not limited to a passenger side air bag module, but could also be used with any air bag module including a driver side air bag module or a side impact or rollover module, for example. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

We claim:

1. An apparatus for helping to protect a vehicle occupant, said apparatus comprising:

an inflatable vehicle occupant protection device having a stored, deflated condition and an inflated condition for helping to protect the vehicle occupant;

an inflator for providing inflation fluid to inflate said protection device; and

a flap made of fabric material, said flap being stored with said protection device, said flap having a first end portion and an opposite second end portion, said first end portion of said flap being fixed relative to said protection device and said second end portion of said flap not being fixed relative to said protection device;

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said flap being deployed by inflation of said protection device into a position adapted to engage and cover a head of a vehicle occupant with said second end portion of said flap adapted to be located over and past the head of the vehicle occupant, said flap being adapted to guide deployment of said protection device over and past the head of the vehicle occupant, said flap being adapted to prevent said protection device from directly engaging the head of the vehicle occupant, said protection device sliding along said flap during inflation of said protection device.

2. An apparatus as set forth in claim 1 for mounting on an instrument panel of a vehicle, the instrument panel having an upper portion extending generally rearward in the vehicle from the vehicle windshield and defining a deployment opening facing generally upward and rearward in the vehicle and having a forward edge portion and a rearward edge portion, said flap when deployed extending from the rearward edge portion of the deployment opening.

3. An apparatus as set forth in claim 1 wherein said protection device has a rearward-facing outer surface portion that is closest to the vehicle occupant when said protection device is inflated, said flap extending along said rearward-facing outer surface portion of said protection device when said protection device is inflated.

4. An apparatus as set forth in claim 1 wherein said flap has first and second major side surfaces, said first major side surface of said flap having a higher coefficient of friction than said second major side surface of said flap, said first major side surface of said flap facing rearward toward the vehicle occupant when said protection device is inflated, said second major side surface of said flap facing forward and extending along a rearward-facing outer surface portion of said protection device when said protection device is inflated.

5. An apparatus as set forth in claim 1 wherein said apparatus includes a housing in which said protection device in the deflated condition and said flap are stored.

6. An apparatus as set forth in claim 1 wherein said apparatus includes a housing in which said protection device is stored in the deflated condition, said flap being folded separately from and overlying said protection device when in the stored, deflated condition.

7. An apparatus as set forth in claim 1 wherein said apparatus includes a housing in which said protection device is stored in the deflated condition, said flap being folded with said protection device when in the stored, deflated condition.

8. An apparatus for helping to protect a vehicle occupant, said apparatus comprising:

an inflatable vehicle occupant protection device having a stored, deflated condition and an inflated condition for helping to protect the vehicle occupant;

an inflator for providing inflation fluid to inflate said protection device; and

a flap made of fabric material, said flap being stored with said protection device;

said flap being deployed by inflation of said protection device into a position adapted to engage and cover a head of a vehicle occupant for guiding deployment of said protection device over the head of the vehicle occupant,

a first end portion of said flap being sewn to said protection device with a permanent stitching section and a second end portion of said flap being sewn to said protection device with a releasable stitching section.

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9. An apparatus for helping to protect a vehicle occupant, said apparatus comprising:

an inflatable vehicle occupant protection device having a stored, deflated condition and an inflated condition for helping to protect the vehicle occupant;

an inflator for providing inflation fluid to inflate said protection device; and

a flap made of fabric material, said flap being stored with said protection device;

said flap being deployed by inflation of said protection device into a position adapted to engage and cover a

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head of a vehicle occupant for guiding deployment of said protection device over the head of the vehicle occupant,

opposite end portions of said flap being sewn to said protection device, said flap having a rupturable portion located intermediate said end portions, said flap rupturing at said rupturable portion upon inflation of said protection device to enable said flap to move into a position engaging and covering the a head of the a vehicle occupant.

* * * * *

EXHIBIT F



US005957487A

United States Patent [19][11] **Patent Number:** 5,957,487**Stütz**[45] **Date of Patent:** Sep. 28, 1999[54] **LATERAL IMPACT PROTECTIVE DEVICE
FOR VEHICLE OCCUPANTS****FOREIGN PATENT DOCUMENTS**[75] **Inventor:** Michael Stütz, Spraitbach, Germany

3422263 12/1985 Germany .
 4307175 9/1993 Germany .
 4166451 6/1992 Japan .
 2278812 12/1994 United Kingdom .
 9419215 9/1994 WIPO .

[73] **Assignee:** TRW Occupant Restraint Systems
GmbH, Alfdorf, Germany

Primary Examiner—Kenneth R. Rice
Attorney, Agent, or Firm—Tarolli, Sundheim, Covell,
 Tummino & Szabo

[21] **Appl. No.:** 08/820,929[22] **Filed:** Mar. 19, 1997[30] **Foreign Application Priority Data**

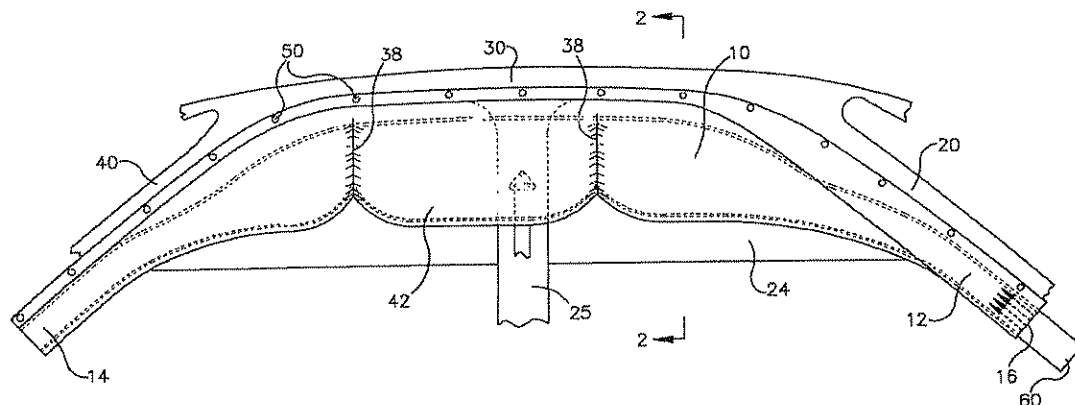
Mar. 29, 1996 [DE] Germany 296 05 896

[51] **Int. Cl.⁶** **B60R 21/22**[52] **U.S. Cl.** **280/730.2**[58] **Field of Search** 280/730.1, 730.2[56] **References Cited****U.S. PATENT DOCUMENTS**

2,834,606 5/1958 Bertrand 280/730.1
 5,788,270 8/1998 Håland et al. 280/730.2

[57] **ABSTRACT**

A lateral impact protective device for a front and a rear vehicle occupant comprises an elongated head gas bag which is convertible from a folded state to an inflated state. The gas bag has two opposite lateral ends and is adapted to extend, in the inflated state, from sideways of said front vehicle occupant as far as sideways of said rear vehicle occupant. The lateral protective device provides a common and, therefore, low-price protection for the front and the rear vehicle occupant.

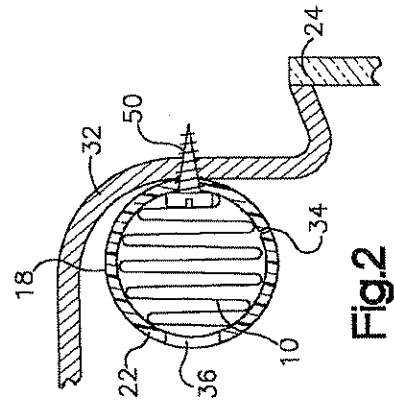
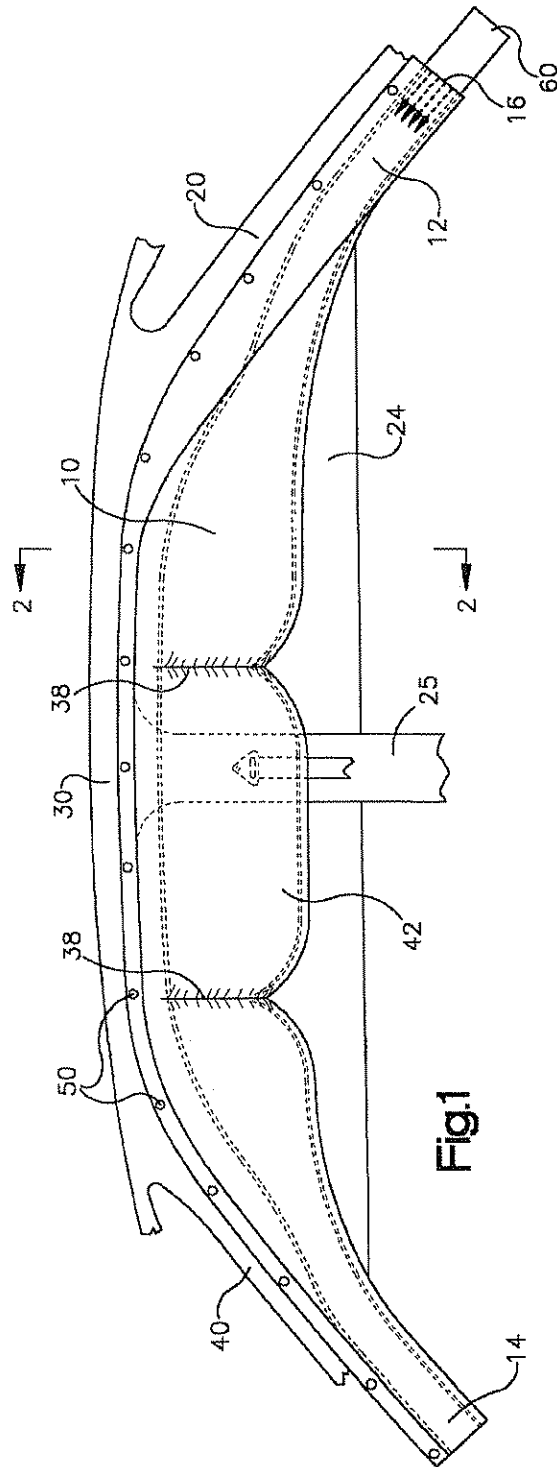
37 Claims, 2 Drawing Sheets

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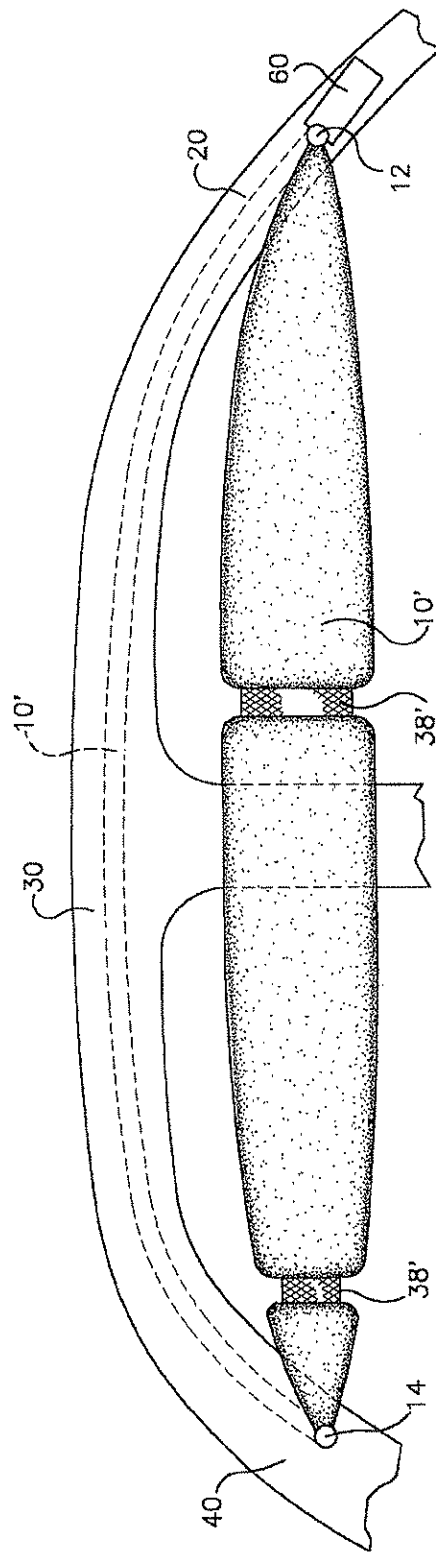


Fig.3

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LATERAL IMPACT PROTECTIVE DEVICE FOR VEHICLE OCCUPANTS

TECHNICAL FIELD

The invention relates to a lateral impact protective device for vehicle occupants.

BACKGROUND OF THE INVENTION

A lateral impact protective device which comprises a head gas bag is disclosed in the patent publication WO 94/19215. The head gas bag described in this printed publication is designed in the form of a flexible hose and at its lateral ends is attached to the A-pillar and to the B-pillar. In the folded up condition, the gas bag extends under a covering along the A-pillar over the roof frame as far as the B-pillar. Since the gas bag is manufactured of a special purpose fabric, its length is substantially shortened during inflation. In the completely inflated state, the gas bag essentially extends linearly from the A-pillar as far as the B-pillar and prevents the head of a vehicle occupant striking the side window of the vehicle.

BRIEF SUMMARY OF THE INVENTION

The invention provides a simple lateral impact protective device which is suitable for front and rear vehicle occupants. According to the invention, the lateral impact protective device comprises an elongated head gas bag which is convertible from a folded state to an inflated state. The gas bag has two opposite lateral ends and is adapted to extend, in the inflated state, from sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant.

The lateral impact gas bag protective device of the invention has a common head gas bag for the front vehicle occupant and the rear vehicle occupant and constitutes a simply installed, low-price protective device, in the case of which just as few parts must be installed in the vehicle as, for example, in the case of the known head gas bag for the front occupant.

In the installed, folded up condition the head gas bag, as a first embodiment thereof, preferably extends along at least a part of the A-pillar, then along the roof frame and along at least a part of the C-pillar of a vehicle. In the longitudinal direction, the head gas bag is non-folded and only has to unfold in the transverse direction so that the inflation process may take place rapidly.

There is the further provision that the inflated head gas bag extends from the A-pillar to the C-pillar and preferably is attached at its opposite ends on the one hand to the A-pillar and on the other hand to the C-pillar. The head gas bag extends, in the inflated state thereof like a flexible hose or cushion along the side windows from the A- to the C-pillar so that, independently of their sitting positions, the front and rear vehicle occupants will be afforded protection against lateral impact.

In accordance with a second embodiment, the head gas bag is not secured only on the A- and C-pillars, but, furthermore, along its upper edge to the roof frame. In this embodiment, the inflated gas bag, consequently, is not only supported on its two ends, but also along the upper edge on the vehicle and hence has greater stability.

The head gas bag can be connected with gas generators, mounted on the A- and/or the C-pillar via suitable gas outlet ports at its corresponding ends.

For simpler fitting in place in its folded state, the head gas bag is preferably arranged in a flexible hose-like fitting

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sheath which can be directly attached to the vehicle without requiring further fixtures. The head gas bag is additionally secured to the vehicle along its edge which is to the top of the head gas bag in the inflated condition thereof.

In accordance with a further embodiment, the lateral impact protective device is designed in the form of a unit able to be retrofitted to a vehicle, the fitting sheath then being preferably manufactured of a flexible material adapting itself to the shape of the vehicle.

The length of the head gas bag, in the inflated state thereof, is less than in the folded state, in which it is installed in the form of an arc along A-pillar, over the roof frame and as far as the C-pillar. Owing to the shortening in length during inflation the head gas bag is drawn taut between its points of attachment after it has emerged from the flexible fitting sheath. The reduction in length may on the one hand be caused by the use of a special purpose fabric, as is described in the said patent publication WO 94/19215 or on the other hand by the provision of at least one element adapted to constrict the head gas bag in the inflated condition, such element extending transverse to the longitudinal direction thereof. The constricting element is preferably attached to the head gas bag and is designed in the form of a string or tape. It can, however, also be attached to the vehicle.

Furthermore there may be a provision such that in the interior of the gas bag a heat resistant foil is present resting against the inner wall surface of the gas bag, such foil being so arranged and of such a size that, in the inflated state of the head gas bag, it is not loaded by pulling forces. This foil does not take up any forces and only exercises a sealing function so that the head gas bag remains completely inflated for several seconds and also provides a protective effect should the vehicle turn over.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a diagrammatic side elevation of a first embodiment of the lateral impact protective device of the invention with an inflated head gas bag.

FIG. 2 shows a section taken on the line A—A of FIG. 1 through a roof frame with the installed, folded up head gas bag.

FIG. 3 is a diagrammatic lateral elevation of a second embodiment of the lateral impact protective device of the invention including a sheath-like head gas bag in the inflated state.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1 the reader will see a lateral impact protective device having a head gas bag 10 designed to offer lateral impact protection both for a front occupant and also for a rear occupant. In the folded up condition thereof the head gas bag 10 extends under the interior vehicle cladding along the A-pillar 20, along the roof frame 30 and along the C-pillar 40. For providing simpler installation of the head gas bag 10 same is arranged in a folded state in a fitting sheath 22 as shown in FIG. 2. The head gas bag 10 does not, however, have to be arranged together with the fitting sheath 22 behind the cladding 32. It is namely possible for the entire lateral impact protective device to be designed as a unit for upgrading an existing vehicle, the fitting sheath 22, as shown in FIG. 2, being attached to the external side of the cladding 32 by means of screws 50. Through openings 36 in the fitting sheath 22 permit access of a screw driver to the attachment

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screws 50. The screws 50 serve not only for the attachment of the fitting sheath 22 but also for attachment of the edge, which is to the top in the inflated state, of the head gas bag to the vehicle.

In the fitted condition a slot-like outlet opening 34 in the longitudinal direction of the fitting sheath 22 points toward the side window 24 so that the head gas bag 10 spreads out toward the side window 24 in a crash and moves into a position between the occupant's head and the vehicle. The fitting sheath 22 is manufactured of a flexible material, preferably a soft plastic, and possesses an oval, round or any other suitable cross section and may be coated in order to ensure easy outward sliding of the head gas bag 10 in the course of inflation.

At least at one end 12 or 14 of the head gas bag 10 same has a gas inlet opening 16, with which it is connected with a gas generator 60. If, however, gas generators 60 are present at both ends 12 and 14, inflation time for the head gas bag 10 may be reduced.

When there is a lateral impact gas will flow into the interior of the gas bag, something indicated by means of the arrows in FIG. 1, and blows up the head gas bag 10 emerging from the fitting sheath 22. In the event of same being arranged under the cladding 32, the cladding 32 will be ripped open. Owing to inflation the length of the head gas bag 10 will be reduced so that it is drawn taut between its points of attachment arranged in the form of an arc. The necessary shortening of the head gas bag 10 in the longitudinal direction is achieved inter alia by the effect of the elements 38 constricting it in the inflated state, such elements extending transverse to the longitudinal direction thereof. The elements 38 are, as indicated in FIG. 1, in the form of strings, which are attached to the wall of the head gas bag 10 itself and extend in the form of a letter U around the lower edge region 42 of the head gas bag 10 and constrict or strangle it so that the head gas bag 10 is in the form of three cushion-like elements which owing to their outwardly directed convex curvature possess a larger surface area. The elements 38 may be arranged at different positions on the head gas bag 10 so that they play a part in determining the configuration of the inflated head gas bag 10 and its longitudinal shortening during inflation.

The head gas bag 10 tapers toward the lateral ends 12 and 14 thereof so that a gas generator 60 arranged on the A- or C-pillar 20 or 40, respectively, may be concealed to the side of the dashboard or in the back part of the back seat and the dashboard tapered section acts a gas duct.

In the interior of the gas bag a heat resistant polyester foil is provided lying against the internal wall surface of the gas bag in the inflated state, such foil being so arranged and of such a size that it does not have to take up any pulling forces in the inflated state of the head gas bag 10.

Whereas in the first embodiment illustrated in FIG. 1 the top edge of the head gas bag 10 extends along the A-pillar 20, along the roof frame 30 and along the C-pillar 40 and the bottom edge region 42 extends as far as a point adjacent to the bottom end of the side window 24, the head gas bag 10 depicted in FIG. 3 is a sheath-like or hose-like element, which is only secured at its ends 12 and 14 to the vehicle. The head gas bag 10 in accordance with this embodiment is locked on the one hand to the A-pillar 20 and on the other hand to the C-pillar 40 on the vehicle. In the folded up state, as is indicated by broken lines, the head gas bag 10 is concealed under the lateral cladding along the A-pillar 20, and under the roof frame 30 as far as C-pillar 40. Several fabric tapes annularly encircling the sheath-like head gas

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bag 10 serve as constricting elements 38 causing shortening of the head gas bag 10 during inflation in the longitudinal direction.

1 claim:

1. A lateral impact protective device for a front vehicle occupant and a rear vehicle occupant of a vehicle, the vehicle including an A-pillar, a roof frame, and a C-pillar, said lateral impact protective device comprising:

an elongated head gas bag which is convertible from a folded state to an inflated state, said gas bag having two opposite lateral ends and being adapted to extend, in the inflated state, from sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant, said gas bag having gas inlet openings at least at one of said lateral ends; and

at least one gas generator, said gas generator being attached to at least one of the A-pillar and the C-pillar of the vehicle and being connected via said gas inlet openings with the interior of said gas bag.

2. The lateral impact protective device as claimed in claim 1 wherein said head gas bag extends, in the folded state thereof, along at least a part of the A-pillar, along the roof frame, and along at least a part of the C-pillar of the vehicle.

3. The lateral impact protective device as claimed in claim 2 wherein said head gas bag extends, in the folded state thereof, from the A-pillar as far as the C-pillar of the vehicle.

4. The lateral impact protective device as claimed in claim 2 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

5. The lateral impact protective device as claimed in claim 3 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

6. The lateral impact protective device as claimed in claim 2 wherein said head gas bag is attached to the A-pillar, to the roof frame, and to the C-pillar of the vehicle.

7. A lateral impact protective device for a front vehicle occupant and a rear vehicle occupant of a vehicle, said lateral impact protection device comprising:

an elongated head gas bag which is convertible from a folded state to an inflated state, said gas bag having two opposite lateral ends and being adapted to extend, in the inflated state, from sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant; and

a hose-like fitting sheath in which said head gas bag is arranged in the folded state thereof.

8. The lateral impact protective device as claimed in claim 7 wherein said fitting sheath is secured to the vehicle and said head gas bag is attached to the vehicle along an upper edge.

9. The lateral impact protective device as claimed in claim 7 wherein said fitting sheath has a slot-like outlet opening extending in a longitudinal direction, the vehicle having a side window toward which said outlet opening points.

10. The lateral impact protective device as claimed in claim 7 wherein said fitting sheath is manufactured of flexible material.

11. The lateral impact protective device as claimed in claim 7 wherein said lateral impact protective device is in the form of a unit adapted to be retrofitted to an existing vehicle.

12. The lateral impact protective device as claimed in claim 7 wherein the vehicle includes an A-pillar, a roof frame, and a C-pillar, said head gas bag extending, in the folded state thereof, along at least a part of the A-pillar, along the roof frame, and along at least a part of the C-pillar of the vehicle.

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13. The lateral impact protective device as claimed in claim 12 wherein said head gas bag extends, in the folded state thereof, from the A-pillar as far as the C-pillar of the vehicle.

14. The lateral impact protective device as claimed in claim 12 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

15. The lateral impact protective device as claimed in claim 13 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

16. The lateral impact protective device as claimed in claim 12 wherein said head gas bag is attached to the A-pillar, to the roof frame, and to the C-pillar of the vehicle.

17. A lateral impact protective device for a front vehicle occupant and a rear vehicle occupant of a vehicle, said lateral impact protection device comprising:

an elongated head gas bag which is convertible from a folded state to an inflated state, said head gas bag having two opposite lateral ends and being adapted to extend in a longitudinal direction, in the inflated state, from a sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant;

said head gas bag having at least one element adapted to partially constrict said head gas bag in said inflated state thereof, said element extending transverse to said longitudinal direction and shortening said head gas bag in said longitudinal direction during inflation.

18. The lateral impact protective device as claimed in claim 17 wherein said head gas bag has a wall and said constricting element is secured to said wall and is in the form of a string.

19. The lateral impact protective device as claimed in claim 17 wherein said head gas bag has a wall and said constricting element is secured to said wall and is in the form of a tape.

20. The lateral impact protective device as claimed in claim 17 wherein said gas bag has a bottom edge portion, said constricting element constricting said bottom edge portion in said inflated state of said gas bag.

21. The lateral impact protective device as claimed in claim 17 wherein the vehicle includes an A-pillar, a roof frame, and a C-pillar, said head gas bag extending, in the folded state thereof, along at least a part of the A-pillar, along the roof frame, and along at least a part of the C-pillar of the vehicle.

22. The lateral impact protective device as claimed in claim 21 wherein said head gas bag extends, in the folded state thereof, from the A-pillar as far as the C-pillar of the vehicle.

23. The lateral impact protective device as claimed in claim 21 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

24. The lateral impact protective device as claimed in claim 22 wherein said head gas bag is attached to one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

25. The lateral impact protective device as claimed in claim 21 wherein said head gas bag is attached to the A-pillar, to the roof frame, and to the C-pillar of the vehicle.

26. A lateral impact protective device for a front vehicle occupant and a rear vehicle occupant in a vehicle, the vehicle having side windows with a bottom part, said lateral impact protective device comprising:

an elongated head gas bag which is convertible from a folded state to an inflated state, said gas bag having two

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opposite lateral ends and being adapted to extend, in the inflated state, from sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant;

said head gas bag extending, in the inflated state thereof, as far as the bottom part of the side windows and tapering toward its end.

27. The lateral impact protective device as claimed in claim 26 wherein the vehicle includes an A-pillar, a roof frame, and a C-pillar, said head gas bag extending, in the folded state thereof, along at least a part of the A-pillar, along the roof frame, and along at least a part of the C-pillar of the vehicle.

28. The lateral impact protective device as claimed in claim 27 wherein said head gas bag extends, in the folded state thereof, from the A-pillar as far as the C-pillar of the vehicle.

29. The lateral impact protective device as claimed in claim 27 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

30. The lateral impact protective device as claimed in claim 28 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

31. The lateral impact protective device as claimed in claim 27 wherein said head gas bag is attached to the A-pillar, to the roof frames and to the C-pillar of the vehicle.

32. A lateral impact protective device for a front vehicle occupant and a rear vehicle occupant in a vehicle, said lateral impact protection device comprising:

an elongated head gas bag which is convertible from a folded state to an inflated state, said gas bag having two opposite lateral ends and being adapted to extend, in the inflated state, from sideways of the front vehicle occupant as far as sideways of the rear vehicle occupant;

said gas bag having an internal wall surface and wherein a heat resistant foil is present in the interior of said gas bag, said foil lying against said internal wall surface and being so arranged and of such a size that it is not loaded by pulling forces in the inflated state of said head gas bag.

33. The lateral impact protective device as claimed in claim 32 wherein the vehicle includes an A-pillar, a roof frame, and a C-pillar, said head gas bag extending in the folded state thereof, along at least a part of the A-pillar, along the roof frame, and along at least a part of the C-pillar of the vehicle.

34. The lateral impact protective device as claimed in claim 33 wherein said head gas bag extends, in the folded state thereof, from the A-pillar as far as the C-pillar of the vehicle.

35. The lateral impact protective device as claimed in claim 33 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

36. The lateral impact protective device as claimed in claim 34 wherein said head gas bag is attached at one of said lateral ends to the A-pillar and at the other of said lateral ends to the C-pillar.

37. The lateral impact protective device as claimed in claim 33 wherein said head gas bag is attached to the A-pillar, to the roof frame, and to the C-pillar of the vehicle.

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EXHIBIT G

U.S. Patent

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FIG. 1

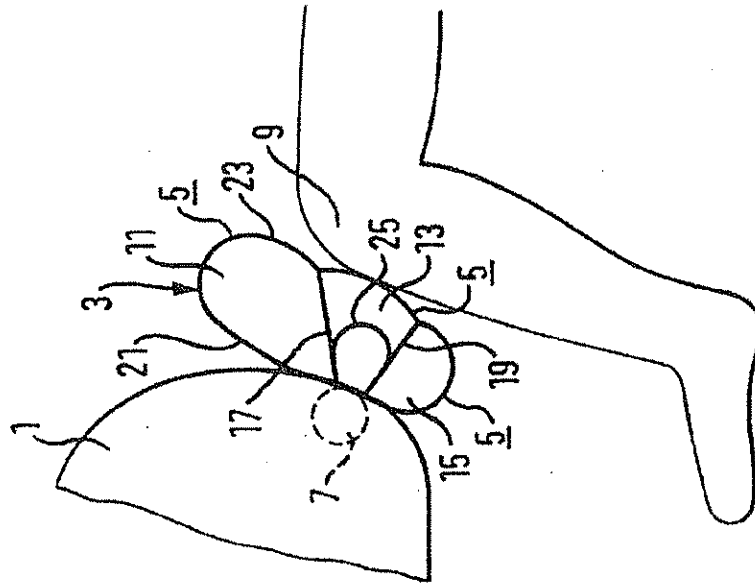
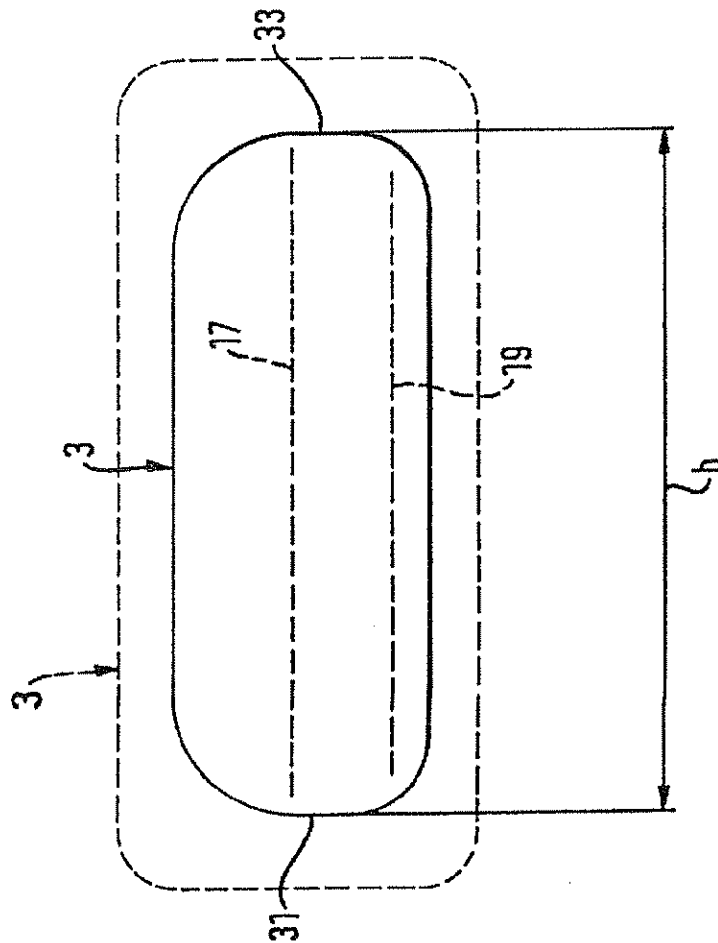


FIG. 2



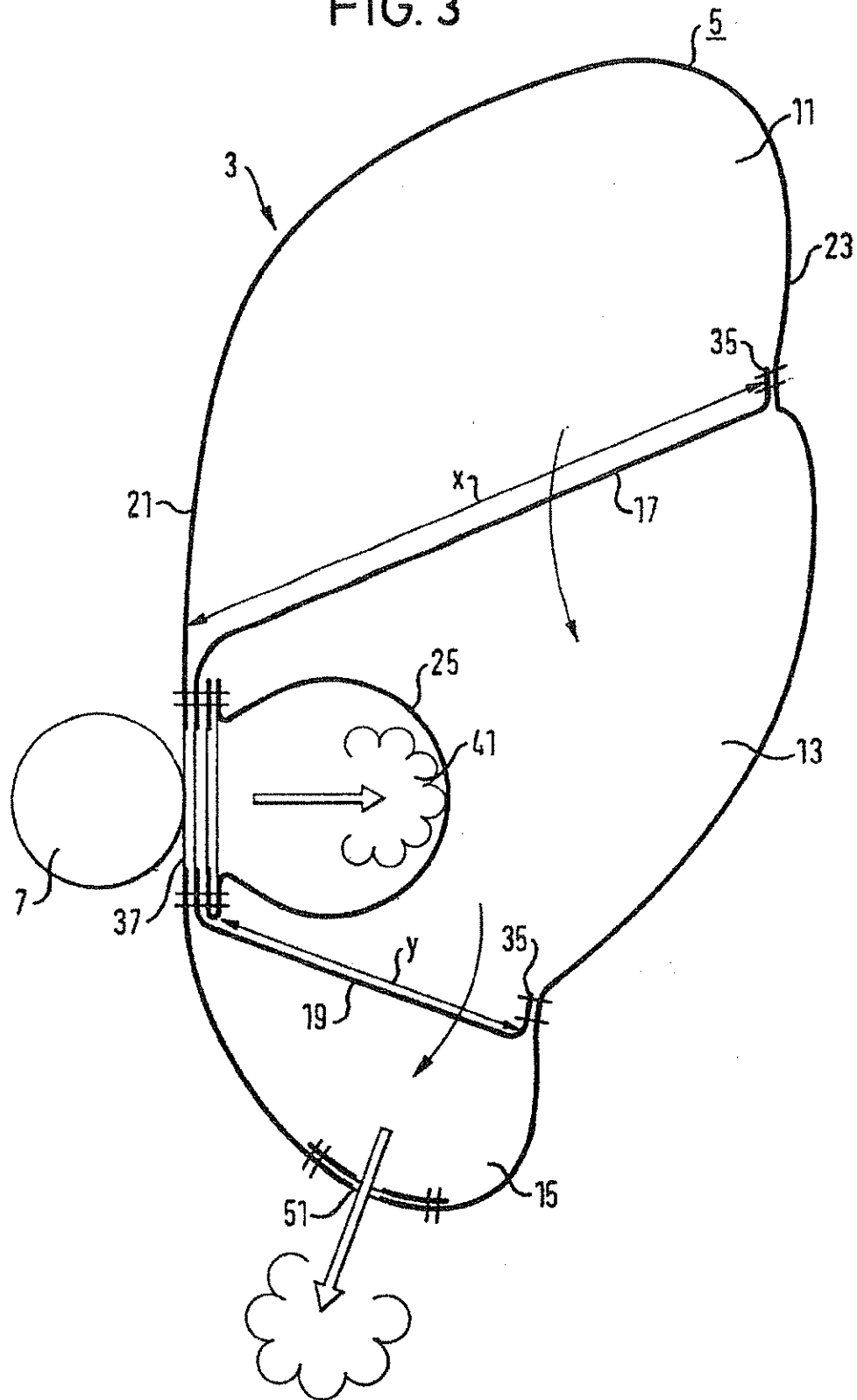
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FIG. 3



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KNEE PROTECTION DEVICE FOR VEHICLE OCCUPANTS

TECHNICAL FIELD

The invention relates to a knee protection device for vehicle occupants.

BACKGROUND OF THE INVENTION

There are various principles hitherto for knee protection devices. On the one hand, systems are known in which a padded plate is moved toward the knees of the occupant in the case of restraint, in order to prevent them from moving. On the other hand, there are knee protection devices with tubular gas bags which in the case of restraint emerge from the instrument panel and extend in front of the knees of the occupant, so that the knees lie directly against the gas bag (and not against a padded plate) and are restrained by the gas bag. In the second system which relates to the present invention, however, there are some disadvantages. Thus the restraining effect of this system depends very much on the size of the contact surface of the gas bag to the occupant. When the knees plunge into the gas bag, the internal pressure of the gas bag increases. However, if the contact of the occupant takes place over a very small area, only a small volume of gas can be displaced, so that the pressure rise in the airbag is very small. This effect is additionally amplified in that the airbag bulges out at different places when the knees plunge into it, which leads to a reduction to the change in volume and reduces the pressure increase. With a small pressure increase, however, only smaller restraining forces are able to be achieved. A further disadvantage relates to the application of the restraining force on the vehicle occupant. In the conventional system, a large part of the force is not introduced into the knee, as required, but rather into the shin bones, because in the case of restraint the occupant lies against the gas bag over a large part of the shin bones up to the knees. The biomechanical reasons (risk of injury) the introduction of force into the shin bones must be minimized.

BRIEF SUMMARY OF THE INVENTION

The invention provides a knee protection device which is distinguished by the application of a high and selective restraining force in the region of the knees. The knee protection device according to the present invention comprises a gas bag having a gas bag wall with opposing sections. The gas bag, in its installed and inflated state, extends in front of the knees of the occupant of the vehicle, lies against the knees in the case of restraint and is intended to largely prevent the knees from moving forward. The device further comprises means in the gas bag which connect the opposing sections of the gas bag wall. The means are fixed to the sections of the gas bag wall and are arranged in such a way that they counteract a change of shape of the gas bag on plunging in by the knees. The invention is based on the knowledge that in fact in gas bags in which the inertia forces by the vehicle occupant moving forward act on a small area on it, a stabilizing of its shape is very important. The means for stabilizing the shape of the gas bag are, for example, limiting straps inside the gas bag and/or dividing walls, to form several chambers. Limiting straps reduce the distance between opposite portions of the gas bag wall, which portions are connected by the straps, compared with a gas bag without the straps.

According to the preferred embodiment, the limiting straps are arranged in such a way that the lower part of the gas bag, in the installed and inflated state, which lies in the

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region of the shin bones in the case of a driver of average size, has a smaller volume and/or a smaller depth than the upper part of the gas bag, which is hit by the knees of the occupant. Thereby, an attempt is made to provide a distance between the shin bones and the gas bag, so that the shin bone no longer has to take up any restraining forces, but rather the available restraining forces are introduced as fully as possible into the knees.

With the provision of one or more dividing walls as means for stabilizing the shape of the gas bag, the dividing wall has at least one overflow opening. If a knee strikes onto a chamber, then the displaced air will endeavor to arrive via the overflow opening into the other chamber. However, this takes place with a great time lag, because the overflow opening acts like a throttle. Hence as a whole a more stable structure of the gas bag is produced with an external action of force. With the provision of several small chambers, in addition, a faster pressure rise takes place.

Preferably, the dividing wall additionally also acts as a limiting strap. The dividing wall hence has a dual function. According to the preferred development, in installed and inflated state of the gas bag the dividing wall extends over approximately the entire width of the inflated gas bag, however, the dividing wall being not secured to or not secured over the entire depth to the gas bag wall. Thereby, overflow ducts are produced on the sides. On unfolding of the gas bag, the dividing walls hardly have a disadvantageous effect with respect to the inflation speed, because in the non-inflated state the gas bag is wider than in the inflated state and large through-flow openings form between the sides of the dividing wall and the lateral sections of the gas bag wall. These over-wide openings permit a rapid overflow of the gas entering into the gas bag from one chamber into the other. Preferably, the dividing wall extends transversely to the vehicle occupant, i.e. in transverse direction of the vehicle. Furthermore, the dividing wall additionally extends preferably from a rear section of the gas bag wall, which is close to the instrument panel of the vehicle, up to the front section facing the occupant.

In order to optimize the unfolding process, preferably a flame protection wall is arranged in the gas bag, which forms a distributor chamber for the inflowing gas and onto which the inflowing gas stream strikes. The flame protection wall is fastened to the rear section of the gas bag wall and in the inflated state is spaced apart from the front section of the gas bag wall. In addition, it is laterally open, so that the incoming gas firstly unfolds the gas bag laterally and hence positions it correctly. Then the gas bag unfolds mainly in the direction of the knees of the occupant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a cross-sectional view of the knee protection device according to the invention, in the installed and inflated state,

FIG. 2 shows a front view of the inflated gas bag as part of the knee protection device according to FIG. 1, and

FIG. 3 shows an enlarged cross-sectional view of the knee protection device according to FIG. 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1 a knee protection device is shown which is accommodated in an instrument panel 1 in the vehicle at the knee level of the vehicle occupant. The knee protection device comprises substantially a gas bag 3 with a gas bag

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wall 5 and a gas generator 7 for the unfolding of the gas bag. The gas generator 7 is arranged hidden behind the instrument panel 1. On unfolding, the gas bag 3 emerges from the instrument panel and pushes itself between the latter and the knees 9 of the occupant. The gas bag 3 has several chambers 11, 13, 15, which are formed by two dividing walls 17 and 19. The dividing walls 17, 19 connect a rear section 21 with a front section 23 of the gas bag wall 5. The rear section 21 faces the instrument panel 1 and the front section 23 faces the vehicle occupant. The dividing walls 17, 19 also act as limiting straps because they are constructed so short that they substantially codetermine the shape of the gas bag in the inflated state, by holding the front section 23 closer to the rear section 21 than would be the case in a corresponding gas bag without dividing walls 17, 19. In the central chamber 13 in addition a flame protection wall 25 is present, which is explained in further detail with the aid of FIG. 3.

In FIG. 2 the gas bag 3 is illustrated with broken lines in spread, unfolded state and with continuous lines in inflated state. The gas bag 3 is very wide, so that it covers all possible points of knee impact in the case of restraint. As can be seen from FIG. 2, on inflation the width of the gas bag 3 reduces to a measure b. The dividing walls 17, 19 extend almost over the entire width b. The dividing walls 17, 19 are only arranged on the front and on the rear section 23, 21, not, however, on the sides 31, 33 of the gas bag wall 5. Hence, slit-like overflow openings are produced on both sides of the dividing walls 17, 19 between the latter and the sides 31, 33.

It can be seen in FIG. 3 that the dividing walls 17, 19 consist of a fabric piece. This piece has opposing edges 35 at which it is sewn to the front section 23 of the gas bag wall 5. A central piece of the part is sewn on the rear section 21 in the region of the inflation opening 37 of the gas bag and has a recess in the region of the inflation opening 37. The part forming the dividing walls 17, 19 therefore represents a reinforcement of the edge of the inflation opening 37. The flame protection wall 25 together with the part which forms the dividing walls 17, 19 is sewn on the edge of the inflation opening 37 and likewise forms a reinforcement of the edge of the inflation opening 37.

In inflated state, the flame protection wall 25 has approximately the shape of a cylinder which is laterally open. Through the flame protection wall 23, a distributor chamber 41 is formed for the gas produced b, the gas generator 7, which flows into the gas bag 3. The length of the dividing walls 17, 19 differs. Whereas the dividing wall 17 has a relatively great length x, the dividing wall 19 with length y is rather short. Hence also the depth of the gas bag in the lower part is distinctly less than in the upper part. This has the advantage that in the lower part of the gas bag a distance is achieved between the shin bones of the occupant (cf. FIG. 1) and the gas bag 3, so that contact between the gas bag and the occupant only occurs in the region of the knees. Hence the restraining force is principally introduced into the knees, where it can develop the greatest restraining effect for the lower body region and the upper thigh region.

At the lower end of the gas bag in addition an outflow opening 51 is provided, which does not open until a certain pressure occurs inside the gas bag. In addition, or alternatively, of course outflow openings can also be provided which are always open (not shown).

The function of the knee protection device in the case of restraint is explained below. As soon as the gas generator 7 is activated, gas flows via the inflation opening 37 into the interior of the gas bag. The gas bag will firstly unfold slightly in the direction of the occupant, until the distributor

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chamber 41 is formed. The gas flow strikes onto the flame protection wall 25 and, after it has divided itself, it is deflected laterally. The gas bag then unfolds almost exclusively laterally and thereby already positions itself at a very early moment. The gas flows laterally from the distributor chamber 41 into the central chamber 13. As a wide slit still exists at the start of the unfolding process between the dividing walls 17 and 19 and the sides 31, 33 of the gas bag, a rapid overflowing of the gas also into the other chambers 11, 15 takes place. The gas bag unfolds upwards, downwards and in the direction of the occupant, until it has reached its full size.

In this state, the dividing walls 17, 19 lie laterally almost or even completely against the sides 31, 33. The position of the gas bag is selected such that the knees of the occupant strike onto the central chamber 13. The knees penetrate into the gas bag and lead to a displacement of gas. This would normally lead to a bulging out of the gas bag wall 25 in regions which are not touched by the knees. Owing to the dividing walls 17, 19 acting as limiting straps, the shape of the gas bag is substantially maintained, however, so that the internal pressure of the gas bag rises distinctly on impact of the knees. The gas displaced by the knees endeavors to arrive into the other chambers 11, 15 via the overflow openings. However, as the overflow openings are relatively small in the fully inflated state, a flow resistance occurs which first has to be overcome so that the overflowing takes place in a delayed manner. Also thereby the internal pressure of the gas bag can rise sharply, which produces a high restraining force. The overflow behavior and hence the course of the pressure rise can be easily adjusted by altering the width of the dividing walls 17, 19 in relation to the width of the gas bag. In order to reduce force peaks, the outflow opening 51 is opened on reaching a predetermined value owing to the internal pressure, so that gas, as indicated by an arrow, can flow out from the gas bag 3.

The optimum position and shape of the gas bag with regard to the position of the knees and of the shin bones of the occupant can be set by the length x, y of the dividing walls 17, 19 and their attachment points at the gas bag wall 5. Instead of the dividing walls 17, 19 a plurality of limiting straps having a reduced broadness can be arranged adjacent to each other. Such limiting straps have the design of the dividing walls, seen in cross section of FIG. 1. The advantages of the knee protection device as shown are essentially:

Rapid and correct positioning of the gas bag in the unfolding process.

Reduction of the change of shape of the gas bag when the knees plunge in, through the provision of means in the gas bag which counteract the change of shape (limiting strap and dividing wall).

Rapid pressure rise and hence reaching of a high restraining force.

Accurate positioning of the sites of introduction of the restraining force into the occupant.

Very favorable manufacture of the gas bag through the combination of dividing walls, limiting straps and the flame protection wall.

What is claimed is:

1. A knee protection device for vehicle occupants, said device comprising

a gas bag having a gas bag wall with opposing sections, said gas bag, in its installed and inflated state, extending in front of the knees of the occupant of the vehicle, lying against the knees in the case of restraint and being intended to largely prevent the knees from moving forward, and

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means provided in said gas bag which connect said opposing sections of said gas bag wall, which are fixed to said sections of said gas bag wall, and which are arranged in such a way that they counteract a change of shape of said gas bag on plunging in by the knees.

2. The knee protection device according to claim 1, further comprising a gas generator for inflating said gas bag.

3. The knee protection device according to claim 1, wherein said means comprise at least one limiting strap arranged in said gas bag.

4. The knee protection device according to claim 3, wherein, in the installed and inflated state of said gas bag, said gas bag has an upper and a lower part, said lower part having at least one of a smaller volume and a smaller depth than said upper part by said at least one limiting strap provided in said lower part.

5. The knee protection device according to claim 1, wherein said means comprise at least one dividing wall provided in said gas bag which connects opposing sections of said gas bag wall with each other and divides the interior of said gas bag into chambers, said dividing wall having at least one overflow opening which provides a flow connection between said chambers.

6. The knee protection device according to claim 5, wherein said dividing wall forms a wide limiting strap.

7. The knee protection device according to claim 5, wherein said dividing wall, in the installed and inflated state of said gas bag, extends over approximately the entire width of said inflated gas bag, said dividing wall being laterally not secured to or not secured over the entire depth to said gas bag wall.

8. The knee protection device according to claim 5, wherein said gas bag wall has a rear section and a front

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section lying opposite thereto and facing the knees of the occupant, and wherein said dividing wall extends from said rear section to said front section.

9. The knee protection device according to claim 8, wherein said gas bag has an inflation opening at said rear section of said gas bag wall, wherein two dividing walls formed from one part are provided, each of which connecting said rear and said front section with each other, said part constituting said dividing walls having opposing edges and a central piece and being secured with said edges to said front section and with said central piece to said rear section of said gas bag wall.

10. The knee protection device according to claim 9, wherein said central piece is fastened to said gas bag wall in a region close to said inflation opening and defines a reinforcement of an edge of said piece surrounding said inflation opening.

11. The knee protection device according to claim 1, wherein said gas bag has an inflation opening in its wall, and wherein a flame protection wall is arranged in said gas bag, which forms a distribution chamber for inflowing gas, said inflowing gas striking directly onto the flame protection wall.

12. The knee protection device according to claim 11, wherein said gas bag has a rear and a front section, and wherein said flame protection wall is fastened to said rear section of said gas bag wall above and below said inflation opening and is spaced apart from said front section and is laterally open in the inflated state of said gas bag.

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